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NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION
Volume II: Proceedings

COMPLETED

Martin L. Reiss

The Institute of Safety Analysis
Washington, D.C.

T76/9/v.2

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FINAL REPORT

281

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16. Abstract

This document represents the proceedings that were given out to the attendees of the symposium on April 9-11, 1979. To the original proceedings have been added a symposium agenda, questions posed and answers provided at the symposium as well as a list of attendees. Twenty-two formal presentations were made. The general areas covered:

- Background (What is exposure data, why is it needed, what does it look like)
- General Needs (At the National Level, for Accident Analysis)
- Measures of Truck Exposure
- Techniques for Exposure Estimation
- Vehicular Observation Techniques
- Uses of Exposure Data

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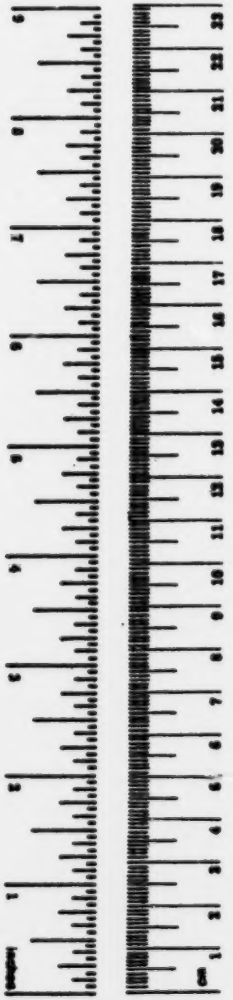
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

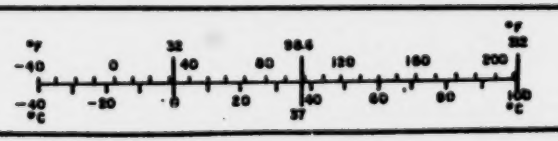
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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ACKNOWLEDGEMENTS

The assistance of Mr. Ezio Cerrelli of NHTSA, and Mr. Michael Freitas of FHWA, in planning the Truck Exposure Estimation Symposium is gratefully acknowledged. A number of persons took care of the day-to-day contacts with the speakers, the hotel, the facility arrangements, the preparation of the preprints and registration materials. We are indebted to those individuals who include Bobbi Fox, Debbie Barr, Maureen Lindsey and Marilyn Zack. Dr. Robert Brenner served as the Chairperson of several of the Technical Sessions. Donald Mela of NHTSA and Michael Freitas of FHWA helped us sum up at the end of the symposium and their inputs are appreciated. Tricia Kelley typed and re-typed our many revisions.

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NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION

AGENDA

Monday, April 9, 1979

7:00 - 9:00 a.m. REGISTRATION

9:00 - 10:30 a.m. SESSION I: OVERVIEW

Chairperson
Robert Brenner
The Institute for Safety Analysis
Washington, D.C.

Welcome
Howard L. Anderson
The Federal Highway Administration
Washington, D.C.

General Impressions of the State of the Art
James O'Day
Highway Safety Research Center
University of Michigan
Ann Arbor, Michigan

Why Exposure Data?
Wallace Berger
Appropriations Committee
United States Senate
Washington, D.C.

Symposium Overview
Martin Reiss
The Institute for Safety Analysis
Washington, D.C.

Questions and General Discussion

10:30 - 10:45 a.m. BREAK

Monday, April 9, 1979 (cont.)

10:45 - 11:30 a.m. SESSION II: GENERAL NEEDS

Chairperson
Martin Reiss

A National Exposure Data System
Arthur Wolfe
The Highway Safety Research Institute
University of Michigan
Ann Arbor, Michigan

On the Need for Truck Exposure Data for Accident Analyses
Gerry Vallette
BioTechnology, Inc.
Falls Church, Virginia

Questions and General Discussion

11:30 a.m. - 1:00 p.m. LUNCH

1:00 - 2:30 p.m. SESSION III: MEASURES OF TRUCK EXPOSURE

Chairperson
Robert Brenner

U.S. Truck Inventory and Use Survey
Carmen Campbell
Transportation Branch
U.S. Census Bureau
Suitland, Maryland

Detailed Measures of Exposure
Hans Joksch
The Center for the Environment and Man
Hartford, Connecticut

Co-Author and Presenter

Joseph Reidy
The Center for the Environment and Man
Hartford, Connecticut

The Truck Operator's View of Exposure Data
John L. Reith
The American Trucking Associations, Inc.
Washington, D.C.

Monday, April 9, 1979 (cont.)

2:30 - 3:00 p.m. BREAK & Unstructured General Discussion by Participants

3:00 - 4:00 p.m. SESSION IV: MEASURES OF TRUCK EXPOSURE (Cont.)

ICC's Data Collection Activities for Commercial Motor Carriers

Robert Ferguson
Office of the Managing Director
Interstate Commerce Commission
Washington, D.C.

Why Do We Need Special Commercial Vehicle Exposure Methods?

David Solomon
Federal Highway Administration
Washington, D.C.

Co-Author and Presenter

Michael Freitas
Federal Highway Administration
Washington, D.C.

Questions

4:00 - 4:30 p.m. GENERAL DISCUSSION OF FUTURE MEASURES OF COMMERCIAL VEHICLE EXPOSURE

Chairperson
Martin Reiss

Tuesday, April 10, 1979

9:00 - 10:30 a.m. **SESSION V: TECHNIQUES OF EXPOSURE ESTIMATION**

Chairperson
Martin Reiss

Investigation of Direct and Indirect Commercial Vehicle Exposure Estimation Methods
Lloyd Philipson
Institute for Safety and System Management
University of Southern California
Los Angeles, California

Data Collection Procedures for Truck Exposure
Fred Hanscom
BioTechnology, Inc.
Falls Church, Virginia

Questions and General Discussion

10:30 - 10:45 a.m. BREAK

10:45 - 11:30 a.m. **SESSION VI: TECHNIQUES OF EXPOSURE ESTIMATION (Cont.)**

Determining Heavy Truck Exposure from Owner Surveys
Kenneth Campbell
Highway Safety Research Institute
University of Michigan
Ann Arbor, Michigan

Truck Exposure Estimation Through Fuel Consumption
Thomas H. May
Bureau of Transportation Planning Statistics
Pennsylvania Department of Transportation
Harrisburg, Pennsylvania

11:30 a.m. - 1:00 p.m. LUNCH

Tuesday, April 10, 1979 (Cont.)

1:00 - 2:30 p.m. SESSION VII: VEHICULAR OBSERVATION TECHNIQUES

Chairperson
Martin Reiss

The Annual Truck Weight Study
Perry Kent
Office of Planning
Federal Highway Administration
Washington, D.C.

Iowa Truck Weight Study Training Procedures
Kenneth R. Shuey
Office of Transportation Inventory
Iowa Department of Transportation
Ames, Iowa

Developing and Using ADT Data at the State and National Level
Richard Bodle
Federal Highway Administration
Washington, D.C.

Questions

2:30 - 3:00 p.m. BREAK & General Discussion Among Participants

3:00 - 4:00 p.m. SESSION VIII: VEHICULAR OBSERVATION TECHNIQUES (Cont.)

Methods for Estimating Exposure of Trucks and Operators
Patricia Waller
Highway Safety Research Center
University of North Carolina
Chapel Hill, North Carolina

Co-Authors
Livia Li
Donald W. Reinfurt

Measuring the Visual Impact of Trucks in Traffic
Richard A. Staley
American Trucking Associations, Inc.
Washington, D.C.

Questions

Tuesday, April 10, 1979 (Cont.)

4:00 - 5:00 p.m. GENERAL DISCUSSION OF FUTURE TECHNIQUES AND NEEDS

Chairperson
Martin Reiss

Wednesday, April 11, 1979

9:00 - 10:00 a.m. SESSION IX: USES OF TRUCK EXPOSURE AND EXPOSURE CONCEPTS

Chairperson
Robert Brenner

Forecasting Motor Carrier Demand and Equipment Requirements
David Anderson
Data Resources, Inc.
Lexington, Massachusetts

Co-Author
Robert W. Schuessler

More Productive Trucks Can Reduce Exposure
Thurm Sherard
Western Highway Institute
San Bruno, California

Questions

10:00 - 10:15 a.m. BREAK

10:15 - 11:00 a.m. GENERAL DISCUSSION OF FUTURE NEEDS AND USES - TRUCK EXPOSURE ESTIMATION

Chairperson
Martin Reiss

Wednesday, April 11, 1979 (Cont.)

11:00 a.m. -
12:00 noon

CLOSING REMARKS*

Chairperson
Robert Brenner

Statement of actions to be considered by the Department of Transportation in response to concepts developed during the Symposium.

Donald Mela
National Highway Traffic Safety Administration

Michael Freitas
Federal Highway Administration

12:00 p.m. **ADJOURNMENT**

*Note: The Conference Room will be held available from 1:00 p.m. to 4:00 p.m. for individuals who wish to continue any of the discussions with their colleagues. TISA representatives will be present to serve as moderators and to take notes of the discussions.

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NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION

April 9-11, 1979
Nassif Building, 400 7th Street, S.W.
Washington, D.C. 20590
Room 2230

SPONSORED BY:

U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Mr. Ezio Cerrelli, Symposium Coordinator
Federal Highway Administration
Mr. Michael Freitas, Symposium Coordinator

SYMPOSIUM OBJECTIVES:

- To discuss the needs for commercial truck exposure estimation
- To consider the current status of commercial truck exposure estimation
- To consider new programs at the local, state and national levels as well to identify new techniques or methodologies that might be utilized in such programs
- To provide a forum for open discussion among symposium participants

NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION

April 9-11, 1979·
Nassif Building, 400 7th Street, S.W.
Washington, D.C. 20590
Room 2230

April 9, 1979

Dear Symposium Attendees:

WELCOME! We hope that the next three days will be a time for sharing information and a time for some constructive thought on what has been a fairly perplexing problem, the estimation of commercial truck exposure data.

We have put together an interesting mix of individuals representing: private industry, university researchers, the trucking industry and various branches of the federal and state government.

We urge you to participate by listening, questioning, and offering your views. We will be addressing why the concept of exposure data is important, what are current practices, measures of exposure, future techniques and future needs.

The Symposium Planning Committee

SESSION I

Welcome

Howard L. Anderson
Associate Administrator for Safety
The Federal Highway Administration

General Impressions of the State of the Art

James O'Day
Highway Safety Research Center
University of Michigan

Why Exposure Data?

Wallace Berger
Professional Staff
Appropriations Committee
United States Senate

NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION

Welcoming Remarks by H. L. Anderson

1. ISSUES:

DOT faced with a changing array of issues related to truck safety.

For example:

Hours of service

121 brakes

Size and weight

Double bottoms

Underride

Cab configurations

Driver training

55 m.p.h. speed limit

2. EXPOSURE DATA:

- Reliable exposure data are needed to pinpoint where corrective safety measures are warranted and to determine how effective these measures are.
- The joint Executive Coordination Group formed by FHWA and NHTSA last year has recognized that the need for better exposure data is currently one of the most critical needs facing the safety community.

- Some exposure data are available, such as:

  Planning data collected by State highway departments.

  ICC data collected from regulated carriers.

  Travel volume data collected by BMCS investigators from motor carriers in Interstate Commerce.

  Bureau of Census data (Truck Inventory and Use Survey).

- However, even when some exposure data are available, they are often not available in a form that makes them useful for dealing with issues such as 121 brakes or truck cab configurations.

3. CONCLUSION:

- Without appropriate exposure data, we are not realizing much of the potential value of the accident data which we are collecting.
- This Symposium should provide valuable emphasis on the importance of improved acquisition of commerical truck exposure information.

GENERAL IMPRESSIONS OF THE STATE OF THE ART

by

James O'Day
University of Michigan
Highway Safety Research Institute

Prepared for presentation at the

Symposium on Commercial
Truck Exposure Estimates

Washington, D. C.

April 9-11, 1979

Exposure in traffic safety is a little like Mark Twain's weather--everybody talks about it, but nobody seems to do anything about it. There have been a fair number of conferences held over the past ten years to talk about this subject, and most of them have culminated in a lot of recommendations which have stopped right there.

When I try to define "Exposure" it seems to be easiest to define it as something which adds to our understanding of accident causes. More recently it has shown some importance in understanding energy usage. Concepts of exposure seem to vary from person to person, or perhaps from problem to problem. At one extreme exposure may take some aggregate data over one variable, and compare vehicle miles traveled under two conditions. At the other extreme one may try to get very detailed disaggregate information.

In the first case, we may be interested in whether males have a higher accident rate than females, whether trucks have a higher accident rate than cars, interstate roads than two-lane highways, etc. A first estimate may be attained by knowing the total miles traveled and the total accidents under each of the two conditions.

Male drivers, for example, have about 70% of the reported accidents; and at first blush this makes the males look pretty bad. But males also drive about 70% of the miles, and this explains most of the variation. Trucks (at least in a study of turnpike accidents where VMT was readily available) had a somewhat higher accident rate than cars.[1] Interstate roads have a substantially lower accident rate than two-lane rural roads.

But very often such simple aggregate measures are not very satisfying. In one model of causation (as discussed by Greenberg[2] in a lung cancer/smoking analysis), cause is defined as a higher probability of a factor being present in the study (say, accident) population than in a control population. But there must be a corollary to such a statement--that all other things must be equal. In

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[1] Campbell, K., Scott, R., and Tolkin, S., "Highway Safety Effects of the Energy Crisis on U. S. Toll Roads", University of Michigan, 1975, UM report Number HSRI-76-5, Contract DOT-HS-801933

[2] Greenberg, B. G., "Problems of Statistical Inference in Health with Special Reference to the Cigarette Smoking and Lung Cancer Controversy," Journal of the American Statistical Association, Vol. 64, No. 327, September 1969.

probability rotation this is:

$$P(F|A,E) > P(F|C,E)$$

where A = Accident Population
C = Control (or exposed) Population
F = Factor of interest
E = Everything else being equal

The simple aggregate data seems to fall down when the problem gets more complex. And then it is necessary to acquire exposure data in a disaggregate form to find an answer.

What is better exposure information going to do for us? This is probably best addressed by example of where we wanted it in the past (and often couldn't get it in the form desired).

Understanding the effects of the energy crisis: During the 1974 oil crisis fuel usage went down, travel decreased, speed was lowered, and accidents were reduced. Many papers were written on the subject of how much of the accident reduction to attribute to the 55 mph speed limit, and how much to reduced travel, etc. Some authors were brave enough to allocate the improvement by percentages. In fact, any simple (aggregate) comparisons were pretty suspect. Everything was not equal--indeed, almost everything changed. VMT changed quite a lot (perhaps down by 15 or 20% overall), but there was very little drop on county roads or on most 2-lane rural roads. There was a very large drop on interstates.[3] I rather expected that teen-age driving would be reduced as parents demanded that the cars be used only for necessary trips; but the evidence was that the biggest reduction was by middle aged males who substituted some other means of travel for their business trips. In a Michigan survey travel on Fridays actually went up (over the previous year) at the peak of the energy shortage. Driving by females was down perhaps 1 or 2 percent; by males down something like 15%. And the teenagers did not seem to suffer at all.

To get at such questions it was necessary to call on many data sources. VMT by road type came from automatic traffic counters which had fortunately been in place for

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[3] Most of the energy crisis exposure material comes from "Effects of the Energy Crisis and 55 M.P.H. Speed Limit in Michigan", by O'Day, J., Minahan, D., and Golomb, D., The University of Michigan, April 1975.

many years...but it was not possible to differentiate between cars and trucks, or between old and young, or male and female drivers. Driver VMT characteristics were taken from a mail survey conducted by Phil Carro[4] (sponsored by NHTSA) which just happened to have taken plac over the two-year period of interest. To some extent th accident data were used to get some induced or implied exposure measures--comparing differences in fatal accidents with differences in all (or non-injury) crashes. But the conclusions as to what effect speed, volume reduction, changes in trip purpose, or changes in driver characteristics, had on accidents were not very convincing.

Occasional special purpose exposure surveys continue to appear from time to time. Campbell[5] has conducted one in connection with the 121 brake system evaluation. Lee[6] conducted a survey of Michigan drivers at relicensing for a period of one year in 1975. Dutt and Reinfurt[7] collected North Carolina odometer data in connection with the vehicle inspection program of that state to permit accident rate comparisons by vehicle make and model. And the census takers have conducted truck in use surveys at the national level.[8] Each of these has been useful, some more generally than others, but none has permitted very direct comparison with all available accident data.

If I knew the solution to this problem we would probably not be having this meeting today. I don't know

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[4] Carroll, Phillip S., "Driver Exposure Survey--A Field Test of the Trip-Log Method", The University of Michigan, February, 1974, final report on contract DOT-HS-031-2-505.

[5] Campbell, Kenneth L., "Preliminary Findings on the Safety Impact of FMVSS 121", Interim Report, The University of Michigan, October, 1978

[6] The data set produced by this survey has produced a number of papers; one example is "Personal Characteristics and Patterns of Vehicle Usage Among Van and Pick-Up Drivers in Michigan", by Martin E. Lee, SAE Paper 790379, March, 1979.

[7] Dutt, A. K., and Reinfurt, D. W., "Accident Involvement and Crash Injury Rates by Make, Model, and Year of Car", University of North Carolina, June 1977

[8] Truck Inventory and Use Survey, 1972 Census of Transportation, U. S. Department of Commerce, Bureau of the Census (Volume II issued March 1974)

about the rest of you, but I can guarantee that I have a problem at least once a week in which I need better exposure information than I have--what proportion of tractor trailer mileage is put on in hours of darkness and on what kinds of highways? How many truck miles on interstate roads are driven on each day of the week or hour of the day? What is the level of experience of drivers of different classes of trucks (say double bottoms vs. singles)? What proportion of trucks in urban service in rainy weather have more than two bald tires (on one side of the truck)? How many gasoline tanker miles are travelled with the tank between half and three-quarters filled?

I doubt that any single survey procedure is going to generate continuing answers to all such questions. But the problems represented by these questions are real, and it would be a much nicer world if I had somewhere to go for most of the answers.

In national problems it is usually most appropriate to think about national samples. Sampling theory will usually permit a rather small number of events to represent the whole nation--if the sample is carefully drawn and surveyed. With the combination of an upcoming energy crisis, and a shift to a vehicle population consisting of mostly very small cars and very large trucks operating on the same roads, it seems even more important that we have a good understanding of what is happening and why accidents occur. I hope that this conference can prove that Mark Twain was wrong, and that, at least for the truck exposure area, we can conclude the talking and produce some continuing activity which will prove useful in the future.

WHY EXPOSURE DATA

(Outline)

By

Wallace G. Berger, Ph.D.
U. S. Senate Appropriations Committee

For Presentation At

NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION

April 9, 1979

MATRIX OF EXPOSURE USES

Level Of Collection Or Use

Functional Category	National	Regional	Local
Social	S_1	S_2	S_3
Economic	E_1	E_2	E_3
Logistic	L_1	L_2	L_3

Social
- Accident data collection, analysis and countermeasures
- Unsafe conditions-overweight and hours of service
- Information needs
- Social objectives-fuel conservation

Economic
- Cost effectiveness of countermeasures
- Cost allocation
- Construction needs
- Economic modeling

Logistic
- Routing-for hazardous materials and weight
- Location of roadway facilities
- Construction planning
- O/D studies

EXAMPLES OF EXPOSURE DATA USE

I. Social Use

A. National

- Determination of accident rates per vehicle class - over and under representation
- Violation of service regulations - enforcement, rulemaking
- Volume determination for special purposes - car pooling and air pollution studies
- Exposure to specific environmental conditions - night, rain, snow, grades, etc.

B. Regional

- Determination of accident rates per vehicle class - over and under representation
- Foreign vs local vehicles - signing requirements
- Violation of service regulations - enforcement
- Exposure to specific environmental conditions - night, rain, snow, grades, etc.

C. Local

- Foreign vs local vehicles - signing requirements
- Identification of hazardous materials movements - routing - safety studies
- Rates for erratic manuevers and surrogate measures
- Volume determination for special purposes - car pooling and air pollution studies
- Accident site identification - countermeasures application

Examples Of Exposure Data Use

II. Economic Uses

A. National

- Determination of cost effectiveness of counter-measures - safety studies
- Cost allocation studies - for assessment of taxes and fees

B. Regional

- Overall roadway volumes (ADT) - construction of alternate routes 3-R work
- Modeling of goods movement - economic
- Determination of truck and special vehicle use - for design plus 3-R
- Determination of cost effectiveness of counter-measures - safety studies
- Cost allocation studies - for assessment of taxes and fees

C. Local

- Overall roadway volumes (ADT) - construction of alternate routes 3-R work
- Determination of truck and special vehicle use - for design plus 3-R
- Weight loading on roadway structures - bridge repair

III. Logistic Uses

A. National

- Identification of hazardous materials movements - routing

Examples Of Exposure Data Use

- Determination of vehicle equivalents - roadway design

B. Regional

- Origin/destination studies - identification of generators, road construction
- Identification of hazardous materials movements - routing
- Location of facilities - rest stops, truck scales, information centers
- Routing - for efficiency,

C. Local

- Origin/destination studies - identification of generators, road construction
- Identification of hazardous materials movements - routing
- Weight loading on roadway structures - routing (bridges)
- Location of facilities - rest stops, truck scales, information centers
- Routing - for efficiency,
- Assess roadway levels of service - highway operations

SESSION II

A National Exposure Data System

Arthur Wolfe
The Highway Safety Research Institute
The University of Michigan

On the Need for Truck Exposure Data for Accident Analyses

Gerry Vallette
Biotechnology, Inc.

ABSTRACT

Paper to be presented at the NHTSA-sponsored Symposium on Commercial Truck Exposure Estimates in Washington, April 7-9, 1979

POTENTIAL COMMERCIAL TRUCK EXPOSURE DATA FROM THE NATIONAL EXPOSURE DATA SYSTEM (NEDS)

Arthur C. Wolfe
Highway Safety Research Institute
The University of Michigan

The National Highway Traffic Safety Administration is seriously considering the establishment of an on-going National Exposure Data System (NEDS) to collect data on many kinds of driver/vehicle exposure to the risk of accident. The main purpose of NEDS will be to provide the exposure complement to the accident data being collected in the National Accident Sampling System (NASS). NEDS will probably involve a household survey with all drivers in a national probability sample of households, and the main procedure of the survey will be asking each selected driver about all trips driven on one or more randomly chosen days. Thus the NEDS program expects to obtain some exposure data from drivers of large trucks. The paper discusses the extent of truck exposure data which can be anticipated from NEDS programs of different sizes and the advantages and disadvantages of obtaining truck exposure data by this means.

Potential Commercial Truck Exposure Data from the National Exposure Data System (NEDS)

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While for many years both roadside and household origin-destination studies have been used to obtain exposure data on motor vehicle travel, the first attempts to obtain nationally representative motor vehicle exposure data took place just ten years ago. In 1969 the Federal Highway Administration (FHWA) sponsored the first Nationwide Personal Transportation Study (NPTS) carried out by the Census Bureau. This involved interviews with close to 12,000 drivers in about 6,000 households, of whom about 150 would have been expected to be truck drivers. Respondents were asked to estimate their annual driving mileages and to provide some basic information about all trips traveled on a recent travel day. However, the eleven reports published by FHWA contain no data for truck drivers as a separate group and very little data concerning trips by truck or concerning on-the-job work trips.

Also in 1969 the National Highway Traffic Safety Administration (NHTSA) contracted with the University of Michigan Highway Safety Research Institute (HSRI) to conduct a national exposure study in state driver license offices (Carroll et al., 1971). Interviews were obtained from 7145 license renewal applicants in 37 offices in 18 states. This study did not really have a nationwide representative sample because at the time only 24 states required in-person license renewal. The data obtained were also less useful than the data from the Census Bureau study since rather than asking for trip-by-trip data for one day respondents were only asked to estimate their mileage for the previous seven and thirty days, to describe the vehicles they used most, and to estimate percentages of driving on four classes of roads, at night, and on wet roads. Some 23% of the respondents said they sometimes drove as part of their employment, and this variable proved to be a major predictor of miles driven in an Automatic Interaction Detector tree analysis.

More recently the Census Bureau has carried out the 1977-78 Nationwide Personal Transportation Study, this time with NHTSA joining FHWA as a sponsor. Interviews about all household members' travel on a given day were obtained in about 20,000 households, including walking and bicycle trips for persons 14 and over. About 35,000 drivers were interviewed among whom about 500 professional truck drivers would be expected. These drivers reported their estimated annual mileage, their on-the-job mileage and vehicle type on the Travel Day, their on-the-job mileage on an average work day, and their average number of days per week driving on-the-job. Such on-the-job trips were not included in the trip-by-trip Travel Day report, but during the last quarter of the survey on-the-job drivers were also asked the total number of work-related stops on the Travel Day and the longest distance driven between two consecutive work-related stops. Thus when the Census Bureau releases the data tapes this spring there will be some nationally representative data available about miles driven on-the-job by type of vehicle for various types of professional drivers.

NHTSA also supported some other exposure research projects in the period between the two national surveys. It awarded some small methodological contracts to Research Triangle Institute and to HSRI,

and in 1973 it sponsored a two-day symposium on driving exposure in Washington which achieved some degree of consensus on vehicle miles of travel (VMT) as the most appropriate exposure measure and on some other basic data elements which should be collected in a driving exposure program (Carroll, 1973).

In recent years NHTSA has spent a great deal of effort in the development of the National Accident Sampling System now in the initial implementation stage. When NASS is fully implemented it is expected to provide detailed data on a nationally representative sample of around 17,000 motor vehicle accidents collected from 30-100 primary sampling areas. The NASS plan calls for oversampling of accidents involving any kind of truck so that about 5600 truck accidents should be included each year. There has been some discussion of oversampling heavy trucks at an even higher rate in order to ensure an adequate national sample of this important class of accidents, but no decision about this has been made yet. The current NASS forms include data on the purpose of the trip on which the accident took place, but they do not ask for driver occupation.

As NHTSA staff considered the goals and operational procedures for the National Accident Sampling System, the importance of an adequate base of exposure data for the calculation of meaningful accident rates became very apparent. Accordingly, in 1977 NHTSA contracted with HSRI to design a cost-effective National Exposure Data System (NEDS) to complement NASS. The report on the general NEDS design was completed last fall (Wolfe, 1978). Basically HSRI recommended the establishment of an on-going program of surveying drivers in households regarding all travel on one or more randomly designated Travel Days. The survey households would be selected from the same primary sampling areas used for collecting the NASS accident data, since this procedure seems most likely to maximize the precision of national accident rates based on vehicle miles of travel. Such an on-going NEDS program would probably, but not necessarily, be conducted by the Census Bureau in much the same way as it carries out other on-going survey programs such as the Current Population Survey, the Annual Housing Survey, and the Health Interview Survey.

Recommended data elements for the NEDS program which are relevant to commercial truck exposure include age, sex, license type, annual mileage, and recent accident experience of each driver; make, model, year, and body type of each vehicle owned or leased by the household; and for each trip on the Travel Day its origin, destination, purpose, distance, beginning and ending times, road moisture conditions, light conditions, weather conditions, distance by four road types, and type of vehicle. For long-haul drivers it should be feasible to obtain the Travel Day data separately for each trip. For local delivery truck drivers, bus drivers, taxi drivers, mailmen, etc. it would undoubtedly be necessary to use a special form for summarizing the data for their on-the-job trips on the Travel Day.

The magnitude of such an annual NEDS household survey depends on how much money NHTSA decides to devote to this purpose. If NEDS is

implemented on a scale similar to the 1977-78 Nationwide Personal Transportation Study with its 20,000 interviewed households, then NEDS would be expected to obtain Travel Day data for about 500 truck drivers, 130 delivery and route men, 85 bus drivers, and 40 taxi drivers. However, professional drivers are probably more difficult than most groups to reach in household interviews, so the above estimates may be somewhat optimistic. Clearly those concerned with commercial truck exposure data would like to have a larger annual data base than that provided by the single Travel Day behavior of 500 truck drivers. Unfortunately over-sampling of truck drivers in a new household survey would be extremely difficult and expensive. However, it might be feasible if the NEDS household sample were selected from a larger sample of previously interviewed households in which resident occupations had already been learned. On the other hand, such a re-interviewing procedure is likely to contribute to an unsatisfactory response rate, as the Census bureau found out in the 1977-78 NPTS which used a sample of previously-interviewed households.

It should be noted that an alternative to the household survey which was discussed in the report on the NEDS design and which has many attractive aspects is the roadside origin and destination survey. To produce nationally representative exposure data such a NEDS survey would require a controlled probability selection of a sample of roadside locations from a listing of all the roads and streets in the NASS primary sampling areas stratified by type and traffic volume. While some of the data elements of interest such as vehicle type could be obtained by human observation or mechanical or camera recording, such important variables as driver age, sex, years of driving experience, seat belt use, and trip purpose (including whether work-related or not), would require personal contact--either stopping the vehicle for a brief roadside interview, or recording the license number and using the state registration files to try to contact the driver later by mail or telephone. Unfortunately, neither of these approaches seems feasible for a long-term survey. Roadside stopping of vehicles is not popular with the local police whose cooperation would be essential, and safety considerations would preclude interviewing on many high-speed heavily traveled roads. But follow-up contacts for the drivers of vehicles observed on such roads would also be very difficult to obtain satisfactorily. There are problems of accurate recording of license plate numbers, of getting state permission to identify the owner in a climate of increasing concern for privacy, of reaching the actual driver on the observed trip through identifying the vehicle owner, and of obtaining an adequate response rate and accurate data from persons contacted some days after the observed trip. There is also a serious question as to whether such a procedure could obtain the required approval of the Office of Management and Budget considering current concerns about government "invasion of privacy."

If such a trip-in-process survey could be carried out successfully, it would have some advantages over the household survey approach. A major advantage of the roadside survey approach is the greater accuracy

and quantity of trip data elements available, particularly in regard to roadway and environmental data. In a household survey it is probably asking too much of many respondents to estimate their trip mileages on freeways, on city streets, and on rural roads. In a roadside survey which used a proper sampling procedure detailed roadway information would be available just by observation (e.g., number of lanes, lane width, shoulder type and width, surface type, etc.) From the point of view of commercial truck exposure a survey which samples trips in process rather than drivers in households is also preferable because it would provide a great deal more truck data. Whereas truck drivers only make up about 1.4% of the driving population (U.S. Bureau of the Census, 1978, p. 421), FHWA (1978, p. 30) estimates that almost 22% of national VMT in 1976 was driven by cargo vehicles, including 4.2% driven just by combination vehicles. Thus a national roadside survey which sampled perhaps 50,000 trips in process would be expected to collect data on about 11,000 trips by trucks and other cargo vehicles and on 11,000 truck drivers.

In summary, there seems to be a strong likelihood that NHTSA will be establishing an on-going National Exposure Data System which will provide at least some annual nationally representative data on commercial truck exposure, probably by household survey rather than by the potentially more useful roadside personal contact survey. If there are additional data elements of particular value to understanding truck exposure which are not included in HSRI's recommendations, such as type of commodity carried or years of truck driving experience, then it would be appropriate for this Symposium to recommend their addition to the NEDS program. It is also possible that a national roadside survey without personal contact, involving human observation and/or mechanical or photographic counting and recording, could provide a great deal of useful data on commercial truck exposure, and the Symposium might seriously consider this exposure data collection procedure.

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On the Need for Truck Exposure for Accident Analysis

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ABSTRACT

The concepts of truck accidents, truck exposure and accident rates are discussed in general. The conduct of a research study where large truck accident data as well as all vehicular exposure data was gathered for a year's period of time at 78 segments of roadway in six states is described.

On the Need for Truck Exposure for Accident Analysis

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On the Need for Truck Exposure for Accident Analyses

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The overall safety implications of large trucks are not yet clear cut. A recent study indicated that several techniques permit an evaluation of their impact on transportation and highway costs. However, it also pointed out that while some data on accident frequency and severity as a function of size and weight were available, data relating truck size and weight, traffic operations, and highway geometry at a national level "were virtually nonexistent" (Voorhees, 1973).

It is incumbent upon cognizant safety personnel to anticipate the safety effects of increases in the size and weight of large truck configurations. Unfortunately, much of the existing data required to address this issue are not adequate to the task. Three types of data are required. The first characterizes the behavior of the traffic stream (traffic operations data). The second type concerns the accident experience of large trucks. The third deals with the relative exposure of large trucks in the traffic environment identified by general vehicle descriptors (truck type, weight, dimensions).

Combining the second and third data types allows one to calculate accident and involvement rates. These rates are much more meaningful than the simple frequency statistics so often quoted. They provide the opportunity to make rational safety comparisons between various classes of vehicles and types of roadways. Rate calculations can determine whether a particular item of interest is over- or under-represented in the accident data relative to its exposure (i.e., opportunity to have an accident) on the highway system. Mathematicaly, rate is represented as follows:

$$\text{Rate} = \frac{\text{No. of accidents}}{\text{No. of (million) miles of travel}}$$

General accident statistics have been available for nearly as long as the vehicles themselves. However, rates can be calculated only if comparable exposure data are also available. Unfortunately, most existing exposure data are not directly related to the available accident data.

Detailed national statistics comparing accident descriptors (such as roadway or truck type) with truck exposure data are just nonexistent. Part of the problem is that relatively few states require the type and size of a commercial vehicle involved in an accident be reported. But the result is that any rate calculations made are tenuous at best, and may be totally wrong in some cases.

The remainder of this discussion focuses on the exposure and accident data historically available, the problems associated with them, and the need for related accident and exposure information.

Truck Accidents

As mentioned, a great deal of data are available about truck accidents in general. National estimates by vehicle type made by the National Safety Council provide limited insights into the total accident picture for cars, trucks, and other vehicles. In addition, aggregate data sources such as NHTSA's National Accident Summary (NAS) and State Accident File Extract (SAFE) files, the Bureau of Motor Carrier Safety files, and MDAI investigations reflect limited subsamples of the truck accident population. In addition to these national files, the individual states maintain accident records to varying degrees of detail.

In general, these figures indicate that trucks are not involved in accidents as frequently as are cars. Within the truck subcategories, articulated combinations have the worst record. However, simple statistics do not give a valid comparison of the different groups. For example, just knowing that doubles have fewer accidents (if that is the case) means nothing if there are fewer doubles than, say, singles in operation; or their exposure (either in vehicle or ton miles) is less. This is even a problem in the area where the most detailed data are available -- fatal accidents. There are wide discrepancies between the various data sources based on how the data are collected, what assumptions are made, and what subsample of the truck population is being discussed. Several caveats must be considered before drawing any general conclusions. Caution must be maintained in using any of these accident statistics other than for comparative purposes, because they represent only fairly gross estimates of the number of accidents that occur.

Truck Exposure

Truck exposure is the term used to describe the number of trucks currently in use and the annual number of miles these vehicles are driven. Fairly accurate information is

available at the state and national levels, through state licensing agencies, on the number of trucks registered each year. These tabulations indicate that trucks represent about 18 percent of the registered vehicles in the U.S. Less than 5 percent of all trucks (including pickups and panels) are classified as articulated combinations. However, as one attempts to classify trucks into categories by configuration, number of axles, weight, length, etc., the information becomes vague or unavailable. In addition, registration figures are not accurate indicators of miles traveled.

The number of miles each classification of truck is driven annually is not specifically available. The truck Inventory and Use Survey conducted by the Bureau of the Census and the annual estimates made by the Federal Highway Administration provide some sample data. The FHWA statistics categorize the number of registered trucks into two classifications: straight (single unit) trucks and combinations. In addition, their annual mileage on rural mainline, rural local, and urban roads is estimated.

As mentioned above, vehicle registration itself is not indicative of actual mileage exposure. The roadway type on which most of the straight truck exposure occurs is the urban street; for the combinations it is the main rural roadway. This intimates that, although only 5 percent of the trucks registered are combinations, their mileage is considerably higher than the straight trucks that tend to stay in urban/suburban areas. In fact, a composite of FHWA and Bureau of the Census data indicates that the one million combination trucks drive approximately 47 percent of the truck mileage. The approximately seven million straight trucks over 10,000 pounds (excluding pickups and panels drive only 53 percent of the mileage.

The major problem with these data is that they are estimates within very general categories. The more detailed the information sought, the greater is the probability that it doesn't exist -- either in the literature or through surveys. Some data on truck exposure by time of day or day of week is provided by manual tallies made at preselected locations (frequently for state ADT gathering purposes). Other data are provided to the Interstate Commerce Commission by fleet owners. The FHWA makes biannual truck weight-gathering efforts. All of these have inherent problems.

A review of the literature shows a small sample of truck exposure studies. The Kentucky Department of Highways (Siria, 1971) obtained comparative data by vehicle type on a major interstate highway. Those data indicated that large trucks comprised about seven percent of the traffic population between 0900 and 1900 hours; they were 22 percent of the total population between midnight and 0400 hours. This fluctuation was due primarily to the large fluctuation of the automobile subpopulation; the number of trucks on the road remained fairly constant.

Another historical source of exposure data is a report by Winfrey (1968). That document has considerable information on truck weights prior to 1964, based on state weight station data. Contrasts by recorded weight (single or tandem axle(s), and gross weight) are provided by roadway types for four truck configurations (3-axle straight, and 3-, 4-, and 5-axle single trailer combinations). Tables in the Winfrey report show trucking trends from 1937 to 1963. For example, while the percentage of tractor-trailer combinations increased (14 to 39 percent), the percentage of single unit trucks decreased (84 to 58 percent). The report also provides some dated accident rate calculations.

Accident Rates

The problem with most of the accident and involvement rates calculations that can be made is that they are really quasi-rates. They are put together using unrelated data sources which themselves are estimates suffering from their own particular bias and unreliability. Certainly, some very general calculations can be made within general vehicle types using, say, recent National Safety Council and Federal Highway Administration data. However, variations between these quasi-rates and any other rates do appear and reflect differences in the definitions of the vehicle classes as well as in the definition of an accident.

In order to clearly delineate between various truck types and parameters, data relevant to these issues must be available. The specificity of the exposure data to be collected must be as specific as the accident data to which it is related. This last point alone -- that the exposure and accident data must be related to each other -- cannot be understressed. Both data must be sufficiently detailed to permit analyses and answer questions of accident and involvement rates such as:

- How do single, double, and triple-trailer rigs differ?

- Are there roadway type differences?
- Does load factor and/or total weight affect the rates?
- Is time of day or day of week a factor?
- Does the relative proportion of trucks in the traffic stream affect rate?
- Is speed (absolute or relative) important?
- What roadway characteristics are important?

In addition to biases, unreliability, and nonspecifity, there is a much more general problem associated with exposure and, to a lesser extent, accident data that are more than two or three years old. Most of the exposure data available today were obtained before the 1973-74 energy crisis. With the introduction of the 55 mile per hour maximum speed limit, a factor was introduced that may have significantly affected all previous estimates of both vehicle mileage and accident involvement. Travel patterns changed drastically, for the first few years following the oil embargo, and may still be different today. The result is that any data pre-1976 or thereabout probably does not reflect what is going on today. This, in combination with greater weight allowances already initiated, can make conclusions based on "historical" data shaky or totally wrong relative to today's situation. This alone could justify the collection of up-to-date exposure data.

As previously mentioned, much of the existing exposure data are not adequate for providing detailed rate analyses and comparisons. Concise exposure data by such factors as: vehicle class, configuration, weight, dimensions, time of day, day of week, and roadway type must be available in order to compute meaningful rate statistics. But not only must they just be available, they must be related to the existing accident data which will appear in the numerator of the rate calculations. That is, exposure should be for the same roadway segments as the accident data, and both types of data should be collected concurrently.

Fortunately, there has been a study which did exactly this type of analysis. BioTechnology, under contract to the Federal Highway Administration, just completed a large-scale truck accident study. This project investigated 2112 large truck accidents on 78 roadway sgements in six states. The sites were selected using a random sampling technique based

on previous accident history such that both high and low accident roads were chosen throughout the study states. The degree to which the six states chosen are representative of the whole United States may be debatable. However, they do represent states which allow a wide range of types and sizes of large trucks (a high percentage of doubles in California, triples in Nevada, heaviest in Michigan, high accident frequency in Pennsylvania, and "baseline" states in Texas and Maryland).

Simultaneously with the 1½-year accident investigation portion of the study, ADT data were also collected. In addition, data were obtained, through various methods described in another paper (Hanscom), on such truck parameters as type, weight, dimensions, cab type, and driver characteristics. (The same as were being collected on the accident-involved trucks.) This is illustrated in Figure 1.

Combining the data bases allowed for rate calculations to be made. Each of the 78 selected sites had definitive terminal points such that its total length was known (e.g., from Milepost 0-24, or between intersections X and Y). By multiplying the frequency of a particular vehicle type traveling through a site by the segment length, the total vehicle miles traveled (VMT) for that type was determined. This is the denominator of the accident rate equation. The numerator is the number of accidents for that type within the same study segment. Sites of similar characteristics (six were identified, such as rural-freeway) were aggregated to get a large enough data base for statistical testing.

It is this sort of accident and exposure data that are required in order to make definitive statements about the relationships between various vehicle and truck types in general, and particular truck parameters specifically. Certainly the cost of a very large-scale detailed study such as BioTechnology's project would be prohibitive. However, ADT and weight data at least are being collected virtually every day. It should be possible to identify sections of roadway throughout the U.S. that are representative of sample segments on which ADT, size and weight, and accident data can be collected. Such procedures are currently being realized for pedestrian accidents. With these related data, the answers to questions such as those posed above can be rationally addressed and quantitatively supported.

Certainly it is fully realized that adoption of the approach suggested here will mean trading the size of the data base for richness of detail and accuracy. However, the data that would be collected would be more precise and

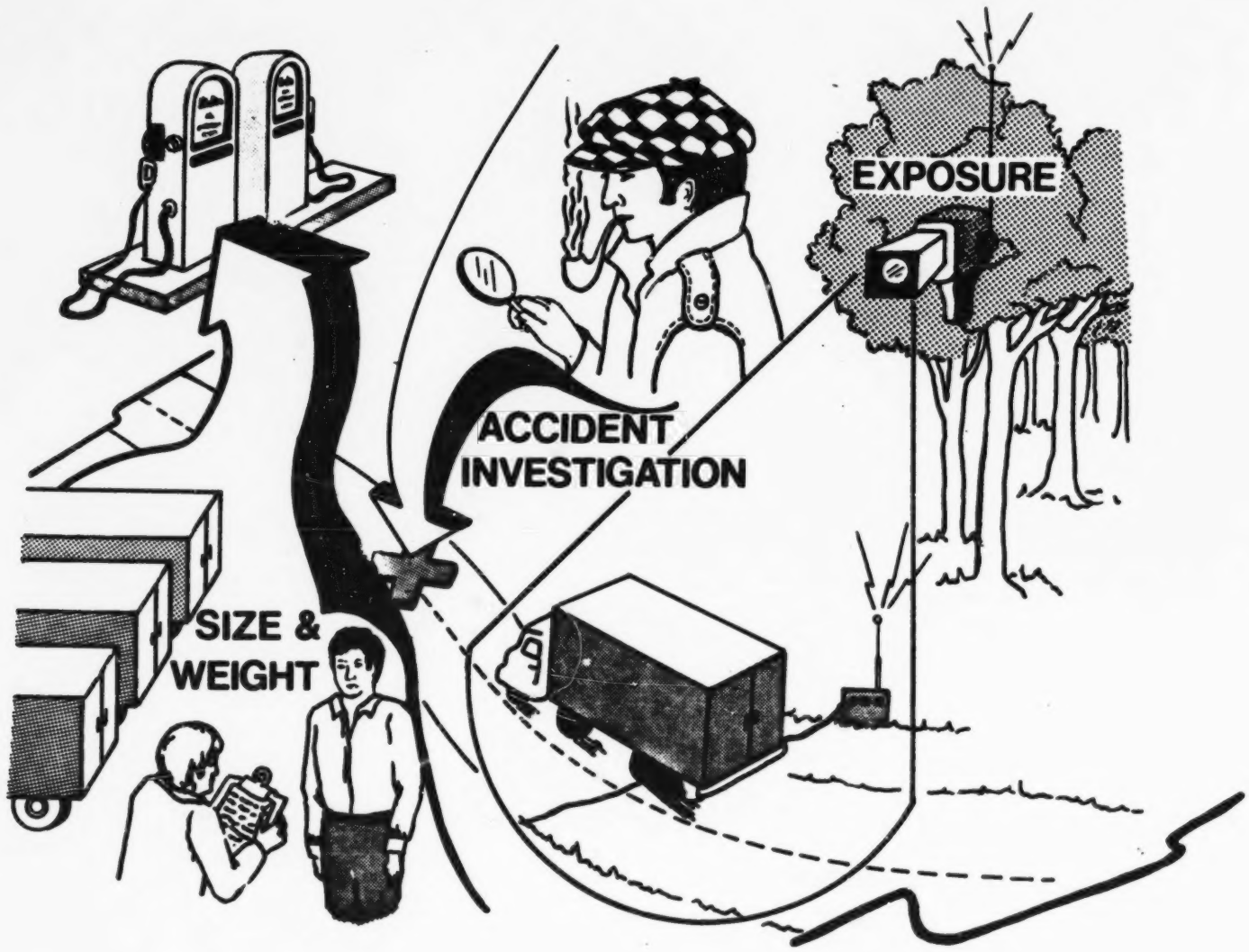

Figure 1. Illustration of simultaneous data collection procedures.

contain more variables of interest than is possible from any manipulations of currently available data. The degree to which a smaller sample can be generalized to the entire United States is a problem that can be worked out. We do believe that understanding the problem situation as a whole at a sample of sites/segments is much better than having questionable accident and involvement rate data on the entire roadway system.

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SESSION III

U.S. Truck Inventory and Use Survey

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Detailed Measures of Exposure

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The Truck Operator's View of Exposure Data

John L. Reith
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The Truck Inventory and Use Survey

by

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Abstract

The purpose, content and use of the Truck Inventory and Use Survey for 1977 are discussed. Among the specific topics presented are the history, survey plan, sample design, questionnaire design and publication contents.

The Truck Inventory and Use Survey

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THE 1977 CENSUS OF TRANSPORTATION - TRUCK INVENTORY AND USE SURVEY

Opening Statements

I would like to thank TISA for inviting a representative of the Bureau to participate in this seminar. We hope that the information given here will be useful in your quest for sources of exposure data.

History

The Census of Transportation is a part of the Economic Census Program, the data for which is scheduled by law to be collected every five years. The Census Bureau's collection authority is limited to data not publicly available from other sources. The current Census of Transportation consists of the Truck Inventory and Use Survey, the Commodity Transportation Survey, Non-regulated Motor Carriers and Public Warehousing Survey, and the National Travel Survey.

The purpose of the Census of Transportation, which has been conducted since 1963, is to fill in the gaps existing in transportation statistics. My talk today will deal specifically with the Truck Inventory and Use Survey, which measures the physical and operational characteristics of the Nation's trucking resources.

Survey Plan

The survey was taken by mail and consists of a sample of 118,000 private and commercial trucks drawn from a universe of approximately 28,000,000 trucks (as estimated by FHWA). The names and addresses were obtained from the registration records of each State's motor vehicle department, as compiled by R.L. Polk and Company. Other basic data included on the questionnaire are make, year model, license number, registered weight and the VIN of the sampled vehicle. Included in the survey methodology were intense follow-up procedures to reduce nonresponse, consisting of two mail followups and a telephone inquiry to obtain missing data or clarify data inconsistencies. The average response rate we're experiencing is approximately 85%.

The completed questionnaires were clerically edited, primarily to prepare responses for data keying. Those records were computer edited and corrected as required. The edited data records will be tabulated and expanded by State to universe estimates representing the base from which the sample was drawn. The detailed estimates will be published in individual State reports and in a U.S. Summary. Previous TIU surveys were expanded to Federal Highway Administration estimates of truck registrations. A computer tape of individual responses will also be available.

Sample Design

Several changes have been made in the sample design to improve estimates of published figures, and to bring the design into conformity with past practices, while preserving established objectives of providing good data for all States and better reliability for States with larger truck populations.

In previous surveys, trucks in each State were stratified into light and heavy categories based on State registered weight. Because of the various registration practices in the States, this procedure lent itself to crossovers of light trucks into heavy categories. Since the bulk of the variance for an estimate comes from light trucks, this was highly undesirable.

For the 1977 survey, stratification is based upon classifying trucks as small vs. large trucks based on body type. Our definition of small trucks includes pickups, panels, and multisteps (walk-ins). All other trucks are considered to be large.

The percent of small trucks in the universe, based on 1974 FHWA estimates, range from 53 - 87%, whereas, large trucks ranged from 20 - 35%. Therefore, a level sample of 600 small trucks was chosen for all States (300 in D.C.) without grossly affecting the variance of the estimates. However, the large truck stratum was sampled on a differential basis by which the States with the higher percentage of large trucks were assigned a larger sample size.

Other changes included the use of random sampling rather than systematic sampling (since most State files were in Zip sequence prior to sampling) and the identification of out-of-scope vehicles prior to sampling (such as Government vehicles, buses, landrovers, ambulances, fire apparatus).

Questionnaire Design

For 1977, the same basic questions were asked as in previous censuses. In consultation with various user groups of TIU data, several new questions were added, but since there were constraints put on the survey (by the Office of Management and Budget) to minimize the respondent's reporting burden, not all suggestions could be used. Some of these users were the Federal Highway Administration, the Environmental Protection Agency, the Motor Vehicle Manufacturers Association, MacKay and Co., Exxon, Cummins Engine, Duetz Diesel, Mack Trucks and Ryder Systems.

The questionnaire is divided into three sections --

- Vehicle identification and use
- Operational characteristics
- Physical characteristics

Specific data items which might be most useful to those seeking vehicle exposure data will be:

type and size of truck	- item 21
annual miles	- item 12a
gross vehicle weight	- item 14
type and size of engine	- item 15
vehicle type	- item 23
axle arrangement	- item 24
area of operation	- item 11
classification of operation	- item 5
major use	- item 6
products carried	- item 7

Publication Plans

The published tables for the States and the U.S. Summary will be basically the same as previous surveys. However, the estimates shown will be expressed in actual numbers of truck units, rather than percents, and the standard errors will be shown on each table rather than in a separate table.

The following tables will be shown in the State Publications:

1. Trucks, Truck Miles and Average Miles.
2. Trucks by Major Use Classes.
3. Trucks by Size Class.
4. Trucks by Annual Miles.
5. Trucks by Range of Operation.
6. Trucks by Truck Type and Axle Arrangement.

The U.S. Summary will show the same tables as above, and additional distributions of trucks and truck miles by major use by geographic area.

Detailed Measures of Exposure

by

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In many different types of traffic safety studies, very aggregate measures of exposure are used. For instance, in studies of driver licensing programs, driver years are often implicitly used. The insurance industry commonly uses "insured vehicle years" in their statistics. Many traffic safety studies use vehicle-miles-of-travel (VMT) as their exposure measure, usually stratifying it by factors of interest, such as highway type, day/night, etc. Highway and traffic engineering studies use hourly or daily traffic volume measures as their exposure base.

Although such aggregate measures may be useful as qualitative indicators of some overall exposure, they are generally conceptually inadequate and, sometimes positively misleading, when they are used in calculating accident rates for various traffic safety analyses. There are various problems. First, there is the fallacy of rate changes: when VMT changes on an otherwise unchanged highway, the traffic density must also change. Since accident risk is related to traffic density, then a change in VMT will change the accident rate per vehicle-miles-of-travel. (To avoid this effect, VMT has to be stratified at least by traffic density. Defining such specific conditions leads one toward the detailed measures of exposure we propose.) A second problem with aggregate measures is the inhomogeneity of accident risk in the aggregate exposure measure. Accident risk is "concentrated" in relatively few traffic situations during a particular trip: intersections, curves, passing situations, etc. Since factors influencing accident risk (speed, road surface condition, etc.) differ between these situations, using an aggregate exposure measure, such as VMT, will not give insights into which factors influence accident risk. Therefore, more specific detailed exposure measures are needed.

In studying exposure to the risk of accidents, we notice two basically different types of traffic situations: extended situations and (essentially, though not literally) instantaneous situations. Examples of extended exposure situations

are such things as driving on a straight road, driving on a (gently) curving road, etc. Instantaneous exposure situations include passing through an intersection, or over a grade crossing, or through a sharp curve. In the case of "instantaneous" exposure situations, the actual duration of the event is of secondary importance. In fact, the influence of duration of the "instantaneous" situation on an accident is not very straightforward, as in the case of passing through an intersection. In the case of extended exposure measures, however, duration of the situation is of primary importance and likely to be directly related to the accident risk.

Both th extended and instantaneous exposure measures can (and, for some analyses, should) be categorized to even finer levels. For instance, to the driving on straight road situations one might further classify driving by speed ranges, highway classes, etc. For the instantaneous situations, one might desire to know whether in passing through an intersection the vehicle turns left, right or goes straight.

This further refinement of the exposure measures begins to reveal an additional level which must be addressed when studying accident risk, i.e., maneuvers. Whether a driver turns left, right or goes straight at an intersection can generally be assumed to be maneuvers "necessary" to reach one's destination and, thus, independent of driver characteristics. Making a U-turn, or passing a car, or going through a red light are <u>not</u> necessary events, though sometimes they are desirable ones. These situations are likely ones with higher accident risk. Passing situations are a good example of this because there are three things to consider. First, the driver decision to pass; second, the selection of the conditions under which the passing maneuver will be made, which is an immediate consequence of the decision to pass or not to pass, under given conditions; third, the actual performance of the passing maneuver and other conditions when passing. While the third aspect determines the accident risk, in the strict sense, the overall risk is a combination of the frequency of the decision to pass and the selection of conditions in which to pass, which determine the accident risk when passing. Different classes of drivers may make different decisions to pass; even though the risks in the passing situation may not differ, their overall accident experience would differ. On the other hand, certain classes of drivers may make the same decisions to pass, but their accident risk when passing may differ. Again, their overall accident risks will differ, but for completely different reasons than in the first example. Such differences are important for understanding

accident causation, and for designing countermeasures. Another example is that the number of turns per mile on a short trip is likely to be larger than on a long trip. Since turns are probably relatively risky situations, one would expect a higher accident rate for short, relative to longer trips, under otherwise comparable conditions. If trip characteristics of certain vehicle types or driver classes would differ, their accident experience would differ because of differences in this fine structure of exposure, not because of differences in risk under comparable situations.

The example of passing raises another point. Passing raises the accident risk not only for the passer, but also for other vehicles, including the one passed. This could be considered "passive" exposure. Since the probability of being passed depends on various factors, including the passed vehicle's speed and headway to the preceding vehicle, a driver can, to some extent, influence his passive exposure and, thereby, his accident risk. To apply this argument to the subject of this conference: if tractor-trailers are going downhill at 65-70 mph, it appears intuitively wise for the drivers of other vehicles to similarly speed up to reduce the passive exposure to a rear end collision or risks when being passed by a truck (due to spray and wind gusts).

A conceptually interesting and most complex situation is "following too closely." If one wants to develop a practically useful and empirically sound definition of "too closely" one has to find an expression for accident risk which can be based on objective data; if, for instance, accident risk, r, might be defined as some function of factors, $x_1 \ldots x_n$, such as the vehicle speeds of each pair of vehicles observed, headway between vehicles, traffic density, braking capabilities, surface friction, etc. Then one has to select (or define) an acceptable level of risk, r_o, such that following "too closely" could be defined by the inequality $r_o < f(x_1, \ldots x_n)$.

Again, "following too closely" appears to be common amongst heavy trucks, at least according to the rule of thumb for "following too closely" (one car length per 10 mph). Since the severity of car-truck accidents is high, a study of this traffic safety problem would be highly desirable. However, from the above discussion, it is obvious that very detailed exposure measures, directly related to some physical model of the accident situation, have to be defined and collected. Gross measures such as accident rates per vehicle mile of travel, even if stratified by a few factors, may at best give an illustrative description of a situation, but no basis for causation studies or countermeasures.

THE TRUCK OPERATOR'S VIEW OF TRUCK EXPOSURE DATA TODAY

by

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Abstract

Exposure measurement in the trucking industry must differentiate between the many differing types of trucks, types of truck operations and other factors which affect the truck safety record.

The first step in adequate exposure measurement is to define a "truck" and a "commercial truck". That will permit a start toward determining whether the vehicle is small and similar in operation to an automobile, or large and more complex in its size and operating characteristics. Too often truck accident data combines pick-up trucks, vans and panel trucks and thus consists of a mix of information that is not applicable to any specific type of truck operation or really useful to safety, regulatory or enforcement activity.

Accident exposure may be different between for-hire and private carriers, and between the operations of company owned vehicles and leased vehicles. To measure the exposure of combination vehicles a careful definition of "combinations" is needed to assure that the data does not include automobiles with boat trailers, dump trucks with construction trailers and other vehicle combinations that involve small trailers.

Comparisons of trucks of differing sizes (lengths) and weights should be based on actual rather than licensed or registered amounts. Comparisons of trucks with other vehicles or other transportation modes must use comparable units of measurement that represent practical operations. Motor vehicle exposure measurement by vehicle miles must include distribution by types of roads, urban or rural travel, day and night travel, congestion, condition and experience of other highway users and weather factors in relation to travel over a range of conditions. In general vehicle miles travelled should be the basic unit of exposure, rather than registration numbers, ton miles, passenger miles or other factors.

THE TRUCK OPERATOR'S VIEW OF ACCIDENT EXPOSURE DATA TODAY

by

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THE TRUCK OPERATOR'S VIEW OF ACCIDENT EXPOSURE DATA TODAY

To begin to understand the meaning of accident statistics and to be able to compare one type of vehicle with another, measurement of exposure to an accident between the various vehicle types and uses is absolutely essential. ATA found this out in 1933 when it established its National Truck Safety Contest.

The Contest is ongoing to this time. It is designed to provide a yardstick by which motor carriers can compare the safety of their operation with that of other carriers. We try to group the carriers into contest divisions so that the competition is between carriers of the same size and type of operation. Basically, we are trying to make certain that the exposure factors are comparable for carriers competing with each other. It hasn't been easy and its far from perfect. We have divisions that group carriers of the same type of operation together - such as tank trucks or heavy haulers. We have mileage classes within divisions and we also divide between local operations and inter-city operations. There is also a grouping for those carriers that use inter-city vehicles for the pick up and delivery of freight in a congested local setting before and after the road movement.

And after 46 years we still have problems. Carriers in the congested Eastern part of the country believe there should be a rating factor to compensate for the low accident exposure of those in the Southwest. Carriers that operate in daylight hours believe they should receive a handicap because of exposure to congestion that doesn't exist for carriers which operate during the night hours.

Obviously, if all vehicles were used for the same purposes and traveled about the same number of miles in any year, over about the same highway system, at about the same speeds and during approximately the same time of day, days of the week and months of the year - if all those factors were about the same for all vehicles, then the question of exposure to accidents might not be very important. But the differences in exposure among vehicle classes are enormous and up to this time we have paid very little attention to really measuring those differences in a meaningful manner in our accident statistics.

Let's examine a few of the so called exposure measures published today. The National Safety Council in its Accident Facts relies on deaths per ten thousand registered vehicles, deaths per 100,000 population, as well as an overall figure of deaths per 100 million vehicle miles. The Bureau of Motor Carrier Safety lists deaths per 100 accidents and the National Highway Traffic Safety Administration publishes data in terms of fatalities per 10,000 licensed drivers.

Such measures are useful for historical purposes, for year to year comparisons, and for indications of broad trends affecting all vehicle types. But they are essentially meaningless in comparing passenger cars, motorcycles, or pick up trucks with freight carrying trucks. For these kinds of comparisons, which are essential to the determination of where our safety problems lie, we need exposure data for different types of vehicles.

The first thing that we will have to do in order to develop adequate exposure data is to come up with vehicle definitions which will be useful for this purpose. That means uniform definitions of the words, truck, commercial truck, and combination vehicle. That will permit a start toward determining whether the vehicle is small and similar in operation to an automobile, or large and more complex in its size and operating characteristics. Too often truck accident data combines pick-up trucks, vans and panel trucks and thus consists of a mix of information that is not applicable to any specific type of truck operation or really useful to safety, regulatory or enforcement activity.

A good start in this direction is to use the visual classification method which has been developed by the Federal Highway Administration. We do need to be careful, however, that combination vehicles should not include pick up trucks pulling farm carts or farm tractors pulling farm trailers or electric utility straight trucks pulling telephone polls on two wheel trailers. Combinations should be limited to vehicles powered by a truck tractor or a straight truck fitted out as a truck tractor and should be separated by axle classifications. That is, three axle, four axle, five axle, and more than five axle should be separate classifications under the combination count for at least two reasons. First of all operating characteristics of three axle combinations as compared to four and five axle are substantially different. The small three axle combination vehicle has become the standard pick up and delivery unit for many general freight motor carriers. Hence, a fairly high proportion of three axle combination miles will be found to take place in urban areas or suburban areas where exposure to accidents is quite high but exposure to fatalities is low.

Four and five axle combinations tend to be the the Rinehaul freight vehicles of the trucking industry; while vehicles with more than five axles are generally specialized equipment which will have a wide variety of differing types of operation. A second reason for suggesting the axle distribution of combination vehicles is that the Federal Highway Administration vehicle mile data is currently collected on this basis and, therefore, would be comparable if accident data were collected under the same definitions.

Definition problems are even more difficult today in the straight truck and automobile classifications. Increasingly today automobiles and all types of straight trucks are pulling camping trailers or boat trailers or fitted out with recreational vehicle bodies. Many of these vehicles are registered like commercial trucks, but have operating characteristics which are totally different. As a consequence, to understand the real exposure to accidents of many of these different kinds of vehicles, some type of sub-classification of the definitions of all vehicle types has become necessary. The exposure to accidents of a three axle straight truck with a flat bed body used around the farm, or fitted with a van and used for local pick up and delivery by a wholesale distributor, or fitted with a mobile home body and used solely for recreational purposes would obviously be greatly different. Even in comparing freight carrying vehicles accident exposure may be different between for hire and private carriers, and between the operation of company-owned vehicles and leased vehicles.

With a common base of definitions, we can then look into the issue of vehicle exposure. It is fairly clear that of the exposure measures in use today, only vehicle miles represent a measure of actual exposure to accidents. But vehicle miles of travel are also a trap. Total vehicle miles all lumped together as if they are all equal in exposure to accidents, produce highly misleading statistics. For example, based on data from the states which serve as a base for the National Safety Council, reports the trucking industry has a superior safety record to that of most highway users. This is based on:

1. All vehicles have a rate of accident involvement of 9.89 per million miles.

2. Tractor semi-trailer trucks have a rate of involvement of 3.25 per million miles.

3. Other trucks have a rate of 6.4 per million vehicle miles.

4. Vehicles other than trucks have a rate of 11.05 per million vehicle miles. So the accident rate of truck is up to 400% better than other vehicles.

But, say our critics, the same National Safety Council data show that fatalities per 100 million vehicle miles for all vehicles are 3.38. Data from other sources shows that combination truck fatalities per 100 million vehicle miles are in a range of 7-8. So combination trucks are twice as likely to be involved in a fatality.

Now the great advantage of these statistics for propaganda purposes is that they don't change from year to year. The figures do change a little bit but the combination vehicle fatality rate is always higher than the passenger car fatality rate. And the combination vehicle accident rate is always a small fraction of the passenger car accident rate. So neither side has to worry that next year it might not want to make that comparison.

In fact, a few years ago we began to notice that the spreads were actually becoming a little wider. After a little thought, the problem with these comparisons quickly became apparent. Both of these comparisons assume that all vehicle miles create the same exposure to accidents. Or put another way, that all vehicles on the highway have about the same travel patterns so that their exposure per vehicle mile is about the same on the average.

The assumption is completely invalid. To cite a few figures from the FHWA mileage data, in 1976 passenger cars traveled 7.3% of their miles on rural interstate highways, combination vehicles traveled 34.3% of their miles on this same system. Passenger vehicles traveled 42½% of their total miles on all rural roads and combinations ran up over 80% of their miles on rural roads. Finally, passenger vehicles traveled 58.5% of their vehicle miles on urban streets, including Interstates, while figures for combinations were only 19%.

Or put another way,the vehicle mile data shows that passenger cars average slightly over 4,000 miles per year on rural roads while all combination vehicles averaged more than 39,000 miles per year on all rural roads. That is almost a ten to one ratio. Now we know that rural travel, particularly Interstate and main rural road travel, is characterized by a low rate of accidents per vehicle mile but because of high speeds, a relatively higher rate of injuries and fatalities per vehicle mile. At the other end of this spectrum, city street travel is characterized by very low speeds, high accident rates and very low injury or fatality rates. So when we know that passenger cars travel nearly 60% of their miles on city streets and combination vehicles travel 80% of their miles on rural roads, we know that the comparisons with which I began this exercise are meaningless for comparison between the various vehicles types.

Now please understand, I am not saying that these figures are meaningless or useless. If passenger cars are defined the same this year as they were last year and the year before, then the figures are perfectly valid to compare how the passenger car rate this year compares with previous years. And the same is true of the various truck rates, so long as the operating or exposure characteristics of the various classes remain approximately the same as it was in the preceeding year. But that is not enough.

We all want to go one step more and compare the experience of passenger cars with recreational vehicles and commercial trucks and various types of combinations. For that purpose the comparisons that I made at the beginning of this discussion are meaningless. Worse than that they are misleading. They send us off tilting at windmills. They are the stuff of transportation myths.

When we review the available safety data today, however, nothing better is available. The FARS Reports point out at the beginning that they do not have any data relating to "exposure to hazard". NASS will not be of much help in this area for sometime, if it ever is.

But the situation is not hopeless by any means. We are already collecting much of the data that we need. It is simply not being collected on a consistent basis and in a consistent manner and assembled in a format which we can use. As an indication of the kinds of things which we can learn from data we are already collecting, let me cite a few examples.

ATA recently conducted a very extensive study among ATA truck fleets. In this study, 34,993 drivers traveled 189,939,000 miles in a 28 day period. They were involved in 672 accidents for an accident frequency rate of 3.39, which is well below the national rate for all vehicles. There were 8 fatalities for a fatality rate of 4.2 deaths per 100 million miles. This is better than the national rural highway death rate of 4.84, a roughly comparable measure. The causes of these fatalities were primarily driver error. In five of the eight fatal accidents, the passenger car driver was clearly at fault while in three the truck driver made an error. The weight of the trucks involved was not a factor in any of the eight. Truck condition and capability were not a factor. The chief cause was driver error - such things as too fast for conditions, failure to comply with the law, failure to pay full attention, etc.

Finally, I have attached to the printed copies of this statement a table which we developed from accident data and vehicle miles data in Indiana. I would not contend that this is definitive, defensible data. We have not reviewed the Indiana State Police Accident Records to analyse the vehicle classification. We know that we have some problems with the vehicle mile data as developed from the state reports, as I know the Federal Highway Administration does too. So the comparisons in this table may or may not be accurate. They are, however, a first step in developing useful comparisons between commercial vehicles and other vehicles giving some consideration to the actual exposure to accidents of different vehicle types. It is a step that must be taken along with many other steps, if we are to be able to compare actual statistics by vehicle type in a truely useful manner. We have the capability, we can develop the data, what we need is an understanding of the basic relationships and the will to complete the job.

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ACCIDENT AND FATALITY RATES IN INDIANA ON RURAL AND URBAN ROADS 1976

TOTAL ACCIDENTS

	RURAL ROADS			URBAN ROADS			ALL ROADS		
Vehicle Type	Number of Accidents	Millions of Vehicle Miles	Rate Per Million Vehicle Miles	Number of Accidents	Millions of Vehicle Miles	Rate Per Million Vehicle Miles	Number of Accidents	Millions of Vehicle Miles	Rate Per Million Vehicle Miles
Combinations	2,629	1,861	1.41	2,240	1,262	1.77	4,869	3,123	1.56
All Other Vehicles	60,823	16,033	3.79	129,130	20,730	6.23	189,953	36,763	5.17
TOTAL	63,452	17,894	3.55	131,370	21,992	5.97	194,822	39,886	4.88

FATALITIES

	RURAL ROADS			URBAN ROADS			ALL ROADS		
Vehicle Type	Number of Fatalities	Millions of Vehicle Miles	Rates Per Hundred Million Vehicle Miles	Number of Fatalities	Millions of Vehicle Miles	Rates Per Hundred Million Vehicle Miles	Number of Fatalities	Millions of Vehicle Miles	Rate Per Hundred Million Vehicle Miles
Combinations	80	1,861	4.30	15	1,262	1.19	95	3,123	3.04
All Other Vehicles	813	16,033	5.07	354	20,730	1.71	1,167	36,763	3.17
TOTAL	893	17,894	4.99	369	21,992	1.68	1,262	39,886	3.16

SOURCES: Standard Summary of Motor Vehicle Traffic Accidents, - 1976, All reported and Truck with Trailers, Truck Tractor; Truck Tractor and Semi-Trailer Indiana State Police.
Highway Statistics - 1976; Table VM2-Vehicle Miles By State and Highway System, Federal Highway Administration. Truck Miles from unpublished data of Federal Highway Administration.

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SESSION IV

ICC's Data Collection Activities for Commercial Motor Carriers

Robert Ferguson
Office of the Managing Director
Interstate Commerce Commission

Why Do We Need Special Commercial Vehicle Exposure Methods?

David Solomon
Chief
Environment Design and Control Division
Office of Research
Federal Highway Administration

The ICC Motor Data Base

by
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ABSTRACT

The Motor Data Base, maintained by the Interstate Commerce Commission, contains financial and statistical information. Data for this data base is collected on annual and quarterly report forms.

Selected items from selected schedules are chosen from the majority of the reports to become part of the Motor Data Base. Information from this data base is used in special studies and also in certain publications, the most notable of which is Transport Statistics in the United States.

THE INTERSTATE COMMERCE COMMISSION'S DATA COLLECTION ACTIVITIES FOR COMMERCIAL MOTOR CARRIERS

BY

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PREFACE:

The responsibility for safety in the trucking industry passed from the Interstate Commerce Commission to the Department of Transportation. Therefore, the question may be asked as to the Commission's role in this symposium on safety. This question is best answered by telling you about the Commission, why it came into existence, and what data it collects, processes, and publishes.

A review of schedules and report forms found in the Appendix may help you to determine the usefulness of the data collected in motor safety. In addition, the bottom line data recommended for the Commission's publication may be a source of statistical data that may assist in motor safety.

INTRODUCTION:

Prior to the establishment of the Interstate Commerce Commission in 1887, regulation of the transportation industry (primarily railroads) was based on the principles of the common law. However, the common law was not able to cope with the problems presented by railroad monoply. It was after the Civil War that the system of economic regulation of railroads that we know today really started. This was initiated by the codification of the Granger Laws from 1871-1874. These laws were tested in 1877 in a series of six litigations before the U. S. Supreme Court called the Granger Cases of 1877. The decision that resulted from these hearings is that the states could regulate rates involving interstate commerce and could take possession of rail and grain elevators when and if they affected the community at large. The Wabash Case of 1886 changed this. In this case the Supreme Court ruled that the state of Illinois could not regulate railroad rates beyond its borders because such regulation violated the commerce clause in the federal constitution.

This decision established the need for a federal agency to regulate interstate commerce. Thus, in 1887 Congress enacted the Interstate Commerce Act which established the first federal regulatory agency, the Interstate Commerce Commission.

In the years that have transpired since 1887, Congress has enacted a number of laws and amendments that have strengthened and broaden the scope of regulation as administered by the Commission. The result of all this legislation and numerous federal court decisions has been an extensive system of regulations which reaches most aspects of railroad operations and prevents monopolization.

During the early 1900's, highway transportation, mainly trucks and buses, was suffering from destructive competition. In order to correct this situation, the states assume regulatory authority over both intrastate and interstate carriers until 1925. In that year the Supreme Court in Buck vs. Kuyhendall, 267 U. S., 307 (1925) and Bush vs. Maloy, 267 U. S., 317 (1925) with respect to the regulatory laws of the state of Washington and Maryland ruled to be unconstitutional the requirement that operating authority be obtained from a state regulatory agency before interstate motor carrier operating could be started.

As in the case of rail, the reason given is that such power was vested in the federal government by the commerce clause of the United States Constitution. A decade later, with the enactment of the Motor Carrier Act of 1935, the motor industry came under the jurisdiction of the ICC.

In addition to rail and motor, the more widely used forms of transportation, the Commission also regulates only 8 percent of water carriers, freight forwarders, and only one pipeline carrier. These regulations protect carriers who are already engaged in interstate commerce; they grant authority to carriers who apply and meet all the necessary requirements and primarily they control rates particularly in the rail and motor area.

To fulfill its responsibilities to the transportation industry and to the public, the Commission is authorized by the Interstate Commerce Act to require annual, periodical, and special reports from carriers under its regulation. The information updated by these carriers is essential to many of the Commission's responsibilities, including the regulation of rates, the valuation of transportation property, and decisions on granting operating authorities, mergers, acquisitions, abandonments, and discontinuing services. In order to carry out these responsibilities, various offices and bureaus of the Commission need financial and statistical information from carriers for various purposes.

Over the history of regulation, the Commission has accumulated an extensive and complex reporting system. Forty-five reports are filed with the Commission on an annual and periodic basis by carriers. Annual reports containing financial and statistical data are required from all carriers regulated by the Commission. Other reports, specifying key items of interest to the Commission, are filed by certain classes of carriers on a monthly, quarterly, or semi-annual basis. From these 45 reports, selected schedules and data items from 27 of these reports are included in the Commission's data base and publications.

REPORTING REQUIREMENTS:

The frequency and kind of reports that are to be filed by a motor carrier depend on the carrier's classification. Specifically, a motor carrier may be a Class I, Class II, or Class III carrier. The carrier who has annual revenue in excess of $3 million is a Class I carrier; a carrier whose annual revenue is between $3 million and $500,000 is a Class II carrier; and a carrier whose annual revenue is betwen $100,000 and $500,000 is a Class III carrier. In addition to this classification, the motor industry is further divided for reporting purposes into General Freight, Other than General Freight, Household Goods, and Passenger. This further breakdown applies to Class I, Class II, and Class III carriers.

Annual Report Form M, filed by Class I and II motor carrier, contains comprehensive financial, operating, and statistical data, such as comparative financial position, equipment, operating revenue and expenses, results of operations, operating taxes and

licenses, employee data and transactions between affiliates. From this report, the following statistical data may be of importance in truck exposure. This would include Commodity Classification of Motor Carriers of Property, Commodities Transported in Intercity Service by tank or hopper type vehicles, operating statistics - intercity service, carriers of freight broken down into intercity vehicle miles and hour.

Class III Motor Carriers of Property file an annual report that shows total operating revenue and expenses and total equipment used and leased. This group of 12.5 thousand represents the major part of the industry, regulated by the Commission.

The ICC also collects information annually from Class I Motor Carrier of Property, approximately 634, on commodity statistics. This report includes truckloads and tons of freight originated, terminated and delivered to connecting carriers, gross freight revenue by commodity codes, and information on hazardous materials.

All Class I and II Motor Carriers of Property report selected items to the Commission on a quarterly basis on a QFR report form. In addition to the financial data collected on this report, there are also data items pertaining to truck and tractor miles operated in intercity freight services and tons of revenue freight transported.

Other report forms used by the Commission in cost studies are forms 2, 4, 7, 10, and 11. These forms are used basically in capturing information on type of truck movements, truckloads, pickup and delivery time studies, platform studies, and peddle-trip operations.

AUTOMATED PROCESSING OF REPORT FORMS:

Of the 45 reports mentioned earlier, 27 of them are automated. That is, selected items within selected schedules are captured and stored in a data base. This data base includes the Class I, II, and III motor carrier annual reports, the transport commodity statistics reports, and the quarterly revenue and statistics reports.

This information is available from the Interstate Commerce Commission in automated form from 1972 through 1977. To obtain it, one would need to contact the Office of the Managing Director.

Automated output from the processing of Cost forms 2, 4, 7, 10, and 11 is available on a three-year cycle. The reason for this is that the Commission divides the United States into 13 cost regions. Each year, for three years, 1/3 of these regions are

selected to be part of the cost study for the coming year. The captured data is edited and then entered into cost formulae to determine the cost of truck movements.

The Commission also performs one-time studies, some of which are of a statistical nature. To mention a few, we have the Independent Trucker Study (a nationwide survey of owner-operators) and an Empty/Loaded Truck Miles on Interstate Highways during 1976. With respect to the latter, data collected from this survey has been automated.

One of the Commission's long-range goals is to consolidate all of the data files into a data base which could be made available to others. Specifically, this data base could be in a time sharing environment where others could access it through their own respective terminals. Another concept is to have motor carriers enter needed data directly into the data base. The advantage to the realization of this concept is immediate access to needed data by a host of users.

REPORT UTILIZATION AND PUBLICATIONS:

Regulated carriers file an original and a duplicate copy of their financial and statistical report with the Commission. One copy is placed in the public reference room, and the other is used for data collection, preparation, and entry into the motor data base.

These reports are available to other federal agencies and the public in the Commission's public reference room. No report is to leave the building. However, xerox copies of reports may be made.

As mentioned earlier, automated motor files on magnetic tape are available to other federal agencies and the private sector. Again, these files contain only selected schedules. Most of the information pertains to the financial status of the motor carrier, some to statistical items on trip miles, weights, commodities, and pickup and delivery time.

From the motor data base, the Commission publishes Transport Statistics in the United States. This publication shows aggregate information on bottom line data taken from financial and statistical report.

Forms 2, 4, 7, 10, and 11 are processed for a succession of three years. At the end of each three years, the Commission publishes this data in a publication entitled Cost of Transporting Freight by Class I and Class II Motor Common Carriers of General Commodities.

Bureaus and Offices throughout the Commission that become involved in special studies, normally have the results of their studies published and made available for distribution. Those who are interested may obtain a list of publications from the Interstate Commerce Commission, Office of Communications and Consumer Affairs, Washington, D. C. 20423. Or they may contact the above office on 275-7252 or toll free 800/429-9312.

SUMMARY:

The Interstate Commerce Commission is authorized by statutory law to regulated the surface transportation industry. One of the major methods used to fulfill this responsibility is a responsive reporting system. Through this system carrier financial and statistical data is acquired, processed, and used by management in their decision-making process. In addition to internal use, part of the processed data is published and released to the public. Ninety-nine percent of the information collected by the ICC is available to the public. Presently, this availability may take the form of magnetic tapes, computer printouts, the actual file copy of the carrier's report, and Commission publications.

REFERENCES:

Interstate Commerce Act as amended through 1973.

Harper, Donald v. Transportation in America, Englewood Cliffs, New Jersey, Prentice-Hall, 1978.

Empty/Loaded Truck Miles on Interstate Highways During 1976, Interstate Commerce Commission, April 1977.

Cost of Transporting Freight, Interstate Commerce Commission, Statement No. 2C16-73.

Schedule 700.—CLASSIFICATION OF MOTOR CARRIERS OF PROPERTY - RESPONDENT ONLY

This schedule is intended to show the principal type of service performed by the respondent. "Principal type of service" is determined by the major source of total operating revenue excluding account 3400, Intercity transportation for other Class I and Class II motor carriers, and account 3900, Other operating revenue.

Show the number of tons transported in intercity service and revenue earned for each of the groups shown in column (a). The totals of columns (b) and (c) should agree with those in column (b) on page 69, lines 13 and 18, respectively; whereas the totals of columns (e) and (f) should agree with those in column (c) on page 69, lines 13 and 18, respectively.

In columns (d) and (g), for the commodity classification with the largest total revenue amount, designate the type of service principally performed using the following symbols:

"A" Regular route - Scheduled service.
"B" Regular route - Nonscheduled service.
"C" Irregular route - Radial service.
"D" Irregular route - Nonradial service.
"E" Local cartage service.

In column (h) report revenues earned from transporting any of the commodity groups shown in column (a) in local cartage service.

In column (i) only the symbol "E" (Local Cartage Service) is appropriate. This symbol is to be entered on the line showing the major source of local revenue reported in column (h).

On lines 17 - 18, specify commodities carried that are not sub-grouped in lines 1 - 16. Specific commodities transported by carriers who may be classified in lines 17 - 18 are shown in the carrier's certificate of public convenience and necessity, or permit (49 CFR, Part 1040.2(q).

Line No	Commodity classification (a)	Intercity Common Carriers (Account 3100) Tons (b)	Revenue (c)	Type service (d)	Intercity Contract Carriers (Account 3200) Tons (e)	Revenue (f)	Type of service (g)	Local (Account 3400) Revenue (h)	Type of service (i)
			$			$		$	
1	General freight								
2	Household goods								
3	Heavy machinery								
4	Liquid petroleum products								
5	Refrigerated liquid products								
6	Refrigerated solid products								
7	Dump trucking								
8	Agricultural commodities								
9	Motor vehicles								
10	Armored truck service								
11	Building materials								
12	Films and associated commodities								
13	Forest products								
14	Mine ores not including coal								
15	Retail store delivery service								
16	Explosives or dangerous articles								
	Specific commodities not subgrouped (specify commodities):								
17									
18									
19	Total								

Carriers which operated during the year as contract carriers as defined in Section 203(a)(15) of the Interstate Commerce Act should furnish the following information: Number of contracts in effect at close of year

Motor Carrier Annual Report M

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Schedule 710.—COMMODITIES TRANSPORTED IN INTERCITY SERVICE BY TANK OR HOPPER TYPE VEHICLES - RESPONDENT ONLY

Common and contract carriers shall report this schedule in cases where more than ten percent of the total intercity transportation revenue for the year is earned from the transportation of commodities by use of owned and leased tank or hopper type vehicles.

Line No.	Class of commodity transported (a)	Tons (b)	Revenue (c)
			$
1	Liquid petroleum products		
2	Refrigerated liquid products		
3	Refrigerated solid products		
4	Agricultural commodities		
5	Building materials		
6	Explosives or dangerous articles		
	Other commodities (specify):		
7			
8			
9			
10			
11			
12			
13			
14			
15	Total		
16	Average number of owned and leased tank and hopper type vehicles used in line haul service		

Schedule 720.—OPERATING STATISTICS - INTERCITY SERVICE, CARRIERS OF FREIGHT

ICC Auth. No.

Definitions For Purposes of This Report

Local service.—Local service, for the purpose of accounting and compiling statistical data, means transportation performed within a municipality and its commercial zone.

Intercity service.—Intercity service, for the purpose of accounting and compiling statistical data, means transportation performed beyond the limits defined for local service.

Truck load.—The term "truck-load," as used in this report, means any shipment which moves on a single bill of lading and weighs 10,000 pounds or more, actual weight.

On lines 4 and 5, if drivers of rented vehicles are on respondent's payroll include miles operated on lines 7 and 8. On line 12, show miles loaded and empty revenue vehicles moved by rail, water or air. On line 14, report tons included in line 13 that were transported by leased equipment with drivers over miles reported on lines 4 and 5. On line 16, show ton-miles of traffic for which payment is included in accounts 5451, 5461 and 5471.

Line No.	A. INTERCITY VEHICLE MILES (All vehicles, loaded and empty, including peddle trips) (a)	Respondent Only	
		Common (b)	Contract (c)
1	Trucks - Owned - Miles operated in intercity service		
2	Tractors - Owned - Miles operated in intercity service		
3	Total miles operated - Owned vehicles		
4	Trucks - Rented with drivers - Miles operated in intercity service		
5	Tractors - Rented with drivers - Miles operated in intercity service		
6	Total miles operated - Vehicles rented with drivers		
7	Trucks - Rented without drivers - Miles operated in intercity service		
8	Tractors - Rented without drivers - Miles operated in intercity service		
9	Total miles operated - Vehicles rented without drivers		
10	Driveaway - Miles operated in intercity service		
11	Total miles operated - All vehicles in intercity highway service		
12	Miles - Rail, water and air services		
	Other Statistics		
13	Tons of revenue freight carried in intercity service (actual weight)		
14	Tons included in line 13 transported by leased equipment with drivers		
15	Ton-miles - Intercity revenue freight - Motor carrier highway service		
16	Ton-miles - Intercity revenue freight - Rail, water and air carrier services		
17	Total ton-miles		
18	Freight revenue from intercity service (accounts 3100 and 3200)	$	$
	Averages		
19	Freight revenue per intercity ton transported (divide line 18 by line 13) (two decimals)	$	$
20	Freight revenue per intercity mile (divide line 18 by lines 11 and 12) (three decimals)	$	$
21	Freight revenue per intercity ton-mile (divide line 18 by line 17) (four decimals)	$	$
22	Ton-miles per intercity vehicle-mile (avg. load) (line 15 ÷ line 11) (two decimals)		
23	Ton-miles per ton (avg. haul) (line 17 ÷ line 13) (one decimal)		

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Schedule 720.—OPERATING STATISTICS - INTERCITY SERVICE, CARRIERS OF FREIGHT—Concluded

B. SUPPLEMENTAL STATISTICS

If correspondent carrier derived an average of 75 percent or more of its revenues from the intercity transportation of general commodities, based on revenues for the latest calendar year, the following information should be furnished on a respondent only basis. Combined revenue on lines 33 and 34 should equal total revenue on line 18. Combined tons on lines 35 and 36 should equal total tons on line 13.

Line No.	Description (a)	Common (b)	Contract (c)
	Number of hours in pickup and delivery service by line haul vehicles:		
24	(a) Vehicles - Owned		
25	(b) Vehicles - Rented with drivers		
26	(c) Vehicles - Rented without drivers		
	Number of miles in line haul service by pickup and delivery vehicles:		
27	(a) Vehicles - Owned		
28	(b) Vehicles - Rented with drivers		
29	(c) Vehicles - Rented without drivers		
	Number of hours in pickup and delivery service by pickup and delivery vehicles:		
30	(a) Vehicles - Owned		
31	(b) Vehicles - Rented with drivers		
32	(c) Vehicles - Rented without drivers		
33	Freight revenue from intercity service - (Actual weight) - 10,000 lbs. and over	$	$
34	Freight revenue from intercity service - (Actual weight) - Up to 10,000 lbs.	$	$
35	Tons of intercity revenue freight carried - (Actual weight) - 10,000 lbs. and over		
36	Tons of intercity revenue freight carried - (Actual weight) - Up to 10,000 lbs.		
37	Number of intercity shipments carried - (Actual weight) - 10,000 lbs. and over		
38	Number of intercity shipments carried - (Actual weight) - Up to 10,000 lbs.		

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Schedule 730.—TRUCKS AND TRACTORS IN INTERCITY REVENUE SERVICE - RESPONDENT ONLY

This schedule should reflect the number of power units on hand at the close of the year. Where a vehicle was in more than one of the categories on the last working day of the year it should be reported in the category applicable for the major portion of that day. On line 5, show rented power units operated by drivers carried on respondent's payroll.

Line No.	Description (a)	Number used principally in		Total (d)
		Intercity (b)	Local (c)	
	Owned power units:			
1	In operation			
2	Undergoing repairs			
3	Stand-by			
4	Rented power units with drivers - In operation			
5	Rented power units without drivers - In operation			
6	Total			

Schedule 735.—PERCENTAGE DISTRIBUTION OF INTERCITY TRAFFIC-COMMON CARRIERS OF PROPERTY - RESPONDENT ONLY

Show for each of the following subdivisions the percentage of total intercity tonnage carried during the year. Estimates may be used if actual figures are not available. State whether estimated or actual.

Line No.	Description (a)	Percent (b)
1	Originated and terminated by reporting carriers	
2	Originated by reporting carrier and delivered to connecting motor carrier	
3	Received from connecting motor carrier and terminated by reporting carrier	
4	Received from connecting motor carrier and delivered to connecting motor carrier	
5	Total	100%

Schedule 740.—REVENUE EQUIPMENT OWNED - RESPONDENT ONLY AND CONSOLIDATED

Line No.	Description (a)	Numbers of Units on Hand at Beginning of Year (b)	CHANGES DURING YEAR			ON HAND AT CLOSE OF YEAR	
			Acquired		Retired		
			Number of Units (c)	Cost (d)	Number of Units (e)	Number of Units (f)	Cost (g)
	RESPONDENT ONLY			$			$
1	Trucks						
2	Truck tractors						
	Semitrailers:						
3	Van						
4	Rack and flatbed						
5	Refrigerator						
6	Tank						
7	Other (Describe)						
8							
9							
10							
11	Total semitrailers						
	Full trailers:						
12	Van						
13	Rack and flatbed						
14	Refrigerator						
15	Tank						
16	Other (Describe)						
17							
18							
19							
20	Total full trailers						
	Other revenue equipment:						
21							
22							
23							
24	Total other revenue equipment						
25	Grand total - Respondent Only						
	CONSOLIDATED						
26	Trucks						
27	Truck tractors						
28	Semitrailers						
29	Full trailers						
30	Other revenue equipment						
31	Grand total - Consolidated						

INTERSTATE COMMERCE COMMISSION
BUREAU OF ACCOUNTS

FORM 7 OF HIGHWAY FORM A
Intercity Trip Report

For an Intercity One-way Trip or a Peddle Trip Operated with either Owned or Rented Equipment. *(See reverse side for instructions and trip report example)*

APPROVED BY GAO B-180230 (R0263)
EXPIRES 9-30-78

SAMPLE DAY

SAMPLE LINE NO. ON TRIP LISTING

NAME OF CARRIER

NAME OF TERMINAL

TYPE OF TRIP (CHECK ✓))

- ☐ WHOLLY EMPTY TRIP
- ☐ INTERCITY TRIP
- ☐ PEDDLE TRIP

Check one:

- ☐ Single Bottom Veh.
- ☐ Double Bottom Veh.

NOTE: BE SURE TO REPORT ALL WHOLLY EMPTY TRIPS AS WELL AS LOADED TRIPS

FOR ICC USE ONLY

		FIELD	
CARD NO. 1 ALL CARDS	CARRIER NO.	(01)	
	TRIP NO.	(02)	
	REGION	(03)	
	TYPE AND NUMBER OF TRIPS	(04)	
	REPLICATE AND WEIGHT	(05)	

CARD NO. 1	ITEM	FIELD	AMOUNT		EXPLANATION
	DRIVER'S WAGES PAID THIS TRIP	(06)	$		
	TOTAL INTERCITY DRIVING TIME	(07)	HOURS	MINUTES	LEAVE OUT TIME AT TERMINALS AND AT SHIPPER POINTS, LAYOVER TIME AND MEAL TIME.
	TOTAL INTERCITY TRIP MILES	(08)			SHOULD AGREE WITH TOTAL MILES IN COLUMN 2 BELOW.

Show name of city or town where tonnage was loaded or unloaded, including trailer drops or pickups. *(See sample on reverse side)*

	CODE	NAME OF CITY OR TOWN (1)	START FIELD	INTERCITY MILES FROM LAST CITY OR TOWN (2)	WEIGHT (pounds) LOADED INCLUDING TRAILER PICKUPS (3)	WEIGHT (pounds) UNLOADED INCLUDING TRAILER DROPS (4)
CARD NO. 1 (Cont'd)	00	START OF TRIP	(09)	X X X	2	X X X
	01	1ST CITY EN ROUTE	(11)			
	02	2ND CITY EN ROUTE	(14)			
	03	3RD CITY EN ROUTE	(17)			
CARD NO. 2	04	4TH CITY EN ROUTE	(05)			
	05	5TH CITY EN ROUTE	(08)			
	06	6TH CITY EN ROUTE	(11)			
	07	7TH CITY EN ROUTE	(14)			
	08	8TH CITY EN ROUTE	(17)		X X X	

½ SEPARATE RECORD OF EACH SHIPMENT WEIGHING 10,000 POUNDS OR MORE WHICH IS INCLUDED IN ABOVE TRIP
(Complete the following or mark "none")

CARD NO. 3	FROM: (City or town shown in column 1)	TO: (City or town shown in column 1)	MILES	WEIGHT (pounds)	ICC USE ONLY START FIELD	CODE O	CODE D
					05		
					08		
					11		

CAUTION: BE SURE SHIPMENTS OVER 10,000 POUNDS ARE SHOWN ON BOTTOM SECTION OF THIS FORM.

SUMMARY: ABSTRACT OF STATISTICS BY DISTRICT
OPERATING STATISTICS

	All Districts	Eastern District	Southern District	Western District	Northern District
Operating Statistics					
Average number of trucks and tractors in intercity revenue					
Owned power units:					
In operation					
Undergoing repairs					
Stand-by					
Total power units -- owned					
Rented power units with drivers--in operation					
Rented power units without drivers--in operation					
Total number power units--intercity revenue service					
Vehicle-miles operated in intercity revenue service (loaded and empty):					
Owned vehicles					
Vehicles rented with drivers					
Vehicles rented without drivers					
Driveaway					
Total miles operated--all vehicles in intercity highway service					
Miles--rail and water services					
Tons of revenue freight carried in intercity service (D)					
Tons included in line transported by leased equipment with drivers					
Ton Miles - Intercity revenue freight - Motor Carrier Highway					
Ton Miles Intercity revenue freight - Rail, water, and air carrier services					
Total Ton Miles					
Freight revenue from intercity service					

(D) Includes duplication as a result of tonnage received from connecting motor carriers.

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SUMMARY: ABSTRACT OF STATISTICS BY DISTRICT
OPERATING STATISTICS

	All Districts	Eastern District	Southern District	Western District	Northern District
Miles -- Rail and water services					
Tons of revenue freight carried in intercity service					
Freight revenue from intercity service					
Total expenses (including depreciation, amortization, and operating taxes)					
Number of carriers represented					
Number of hours in pickup and delivery service by line haul vehicles:					
Vehicles -- owned					
Vehicles -- rented with drivers					
Vehicles -- rented without drivers					
Number of miles in line haul service by pickup and delivery vehicles:					
Vehicles -- owned					
Vehicles -- rented with drivers					
Vehicles -- rented without drivers					
Number of hours in pickup and delivery service by pickup and delivery vehicles:					
Vehicles -- owned					
Vehicles -- rented with drivers					
Vehicles -- rented without drivers					
Freight revenue from intercity service--					
Truck load					
Less truck load					
Tons of intercity revenue freight carried --					
Truck load					
Less truck load					
Number of intercity shipments carried --					
Truck load					
Less truck load					

SUMMARY: ABSTRACT OF STATISTICS BY DISTRICT
REVENUE FREIGHT EQUIPMENT, ACQUIRED, AND RETIRED FROM SERVICE DURING THE YEAR

		All Districts	Eastern District	Southern District	Western District	Northern District
Number of carriers represented						
Equipment acquired during the year:						
Trucks	- Number of units					
	- Cost					
Trucks Tractors	- Number of units					
	- Cost					
Semitrailers	- Number of units					
	- Cost					
Full Trailers	- Number of units					
	- Cost					
Other Equipment	- Cost					
Total cost of all equipment acquired						
Equipment retired during the year:						
Trucks	- Number of units					
Truck Tractors	- Number of units					
Semitrailers	- Number of units					
Full Trailers	- Number of units					
Equipment owned at close of year:						
Trucks	- Number of units					
	- Cost					
Truck Tractors	- Number of units					
	- Cost					
Semitrailers	- Number of units					
	- Cost					
Full Trailers	- Number of units					
	- Cost					
Other Equipment	- Cost					
Total cost of all equipment owned						

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SUMMARY: ABSTRACT OF STATISTICS BY DISTRICT
EMPLOYEES: AVERAGE NUMBER, TOTAL COMPENSATION, TOTAL HOURS EARNED AND WORKED BY CLASSES

	All Districts	Eastern District	Southern District	Western District	Northern District
Vehicle repair and service					
Average number of employees					
Total hours earned					
Total hours worked					
Amount of wages					
Owner-operator drivers mileage basis					
Average number of employees					
Total miles					
Amount of wages					
Owner-operator drivers other basis					
Average number of employees					
Total hours earned					
Total hours worked					
Amount of wages					
Other labor					
Average number of employees					
Total hours earned					
Total hours worked					
Amount of wages					
Employees engaged in freight operations					
Average number of employees - Total					
Total miles					
Total hours earned					
Total hours worked					
Total amount of wages					

SUMMARY: ABSTRACT OF STATISTICS BY DISTRICT
OPERATING STATISTICS

	All Districts	Eastern District	Southern District	Western District	Northern District
Number of carriers represented					
Average number of trucks and tractors in intercity revenue service:					
Owned power units:					
In operation					
Undergoing repairs					
Stand-by					
Total power units -- owned					
Rented power units with drivers -- in operation					
Rented power units without drivers -- in operation					
Total number power units -- intercity revenue service					
Vehicle-miles operated in intercity service (loaded and empty):					
Owned vehicles:					
Trucks					
Tractors					
Total miles operated -- owned vehicles					
Rented with drivers:					
Trucks					
Tractors					
Total miles operated -- rented with drivers					
Rented without drivers:					
Trucks					
Tractors					
Total miles operated -- rented without drivers					
Driveaway					
Total miles operated -- All vehicles in intercity highway service					

Why do We Need Special Commercial Vehicle Exposure Methods?

by

David Solomon
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202/426-0291

Abstract

Many comparisons of commercial vehicle accidents have utilized exposure measures based on vehicle-miles/kilometres or on numbers of vehicles entering intersections/spot locations. For certain types of comparisons, such exposure measures are adequate. For comparisons of different sizes of vehicles, exposure measures based on ton-miles carried are more meaningful. These and other even more sophisticated exposure measures will be discussed and their advantages and disadvantages compared.

COMMERCIAL VEHICLE EXPOSURE MEASURES

by

David Solomon, Chief, Environmental
Design and Control Division
Office of Research
Federal Highway Administration
Washington, D. C.

April 9, 1979

Special commercial vehicle exposure measures are needed to compute rates and to provide information which will aid transportation officials in making key decisions. This paper will discuss (1) computation of hazard rates, (2) types of key decisions to be made, (3) special problems of diversion of freight from rail to truck, and (4) other considerations including nonsafety aspects of the problem.

Computation of Hazard Rates

In comparing the safety of highway travel, accident or fatality rates (i.e., the number of accidents or fatalities per 100 million vehicle-miles of travel) are typically used. Such general comparisons are useful, for example, in distinguishing between the safety of freeways compared to conventional highways. They show that freeways have fatality rates about 1/3 that of conventional highways.

When considering the hauling of freight, a suitable comparison might be based on the number of truck accidents or fatalities per 100 million truck-miles of travel on a freeway versus a conventional highway. Again the freeway is found to be much safer. Such a comparison would be reasonably valid if trucks on freeways and trucks on conventional highways were of similar configuration, e.g., if all trucks being compared were tractor semi-trailers. Unfortunately, many of the more useful comparisons involve trucks of different configurations. For example, it has been found desirable to compare relative safety of tractor semi-trailers (single bottoms) with tractor semi-trailers and full trailers (double bottoms) either on the same highway or on different highways. In some States, single bottoms may use either freeways or conventional highways while double bottoms are limited to freeways. In such cases better comparisons could be made if hazard rates were based on ton-miles hauled rather than on truck-miles or vehicle-miles. By using ton-miles, it is possible to answer the following question: if it is desired to ship a certain quantity of freight a certain distance, what are the relative hazards involved in using single bottoms compared to double-bottoms; assuming that both use the same types of highways.

The hypothetical example shown in Table 1 makes this clear. Although the hypothetical vehicle-mile accident rate for single bottoms and double bottoms is about the same, the ton-mile accident rate for the double bottoms is considerably lower because that vehicle carries more freight and fewer vehicles are needed. Although the vehicle-mile fatality rate in

the hypothetical example is greater for the double bottoms, the ton-mile fatality rate is approximately the same because fewer double bottoms are required to carry the same freight.

Types of Key Decisions

Clearly the key reason for special commercial vehicle exposure measures is to aid in making key transportation and commodity shipment decisions. Following are some examples of decisions to be made in response to specific questions:

1. Which type of vehicle has fewer accidents for a given amount of travel? These questions frequently involve such comparisons as cab over engine designs vs. cab behind engines or older vehicles vs. newer vehicles. They may also involve age comparisons of drivers, day vs. night comparisons, and different types of highways. Exposure measures based on vehicle-miles or truck-miles are appropriate here.

2. Given that certain vehicles are much safer on a vehicle-mile basis, will overall accidents be reduced if extra travel is required to ship by using these vehicles? An example would be use of barges on inland waterways. Such travel has a very low accident rate, but travel distances tend to be much longer for many types of shipments. The exposure measure should desirably be based on tons shipped per trip between specific points of origin and destination.

3. What is the safest way of shipping a certain quantity of material a certain distance? The comparisons here may be based on ton-miles. Further refinement may involve stratification by commodity type to provide more precise comparisons for low density commodities that use all available space (cube out) vs. very dense commodities that are limited by allowable maximum axle and/or gross load limits (gross out).

4. How and when should valuable commodities be shipped? Here comparisons would involve vehicle-mile rates by various modes and would include specific routes, e.g., freeways vs. 2-lane rural, time of day, day of the week, weather conditions, and other factors. In some cases, freeways would be the preferred route even with 30 to 40 percent extra distance. In other cases, air or rail might be preferred even for short distances. The comparison would be based on individual shipments between origin and destination.

5. If larger trucks are permitted on the Nation's highways, will diversion of freight from rail to truck result in a net increase in accidents? The next section will discuss this very important and controversial issue.

Diversion from Rail to Truck

The hypothetical example shown in Table 1 indicates that, on a ton-mile basis, the accident and fatality rates for rail shipments are approximately 2/3 that of triple bottoms. Therefore, if the required decision is whether it is safer to ship grain by rail or by triple bottom, rail is clearly the safer mode.

In many instances, however, the required decision is much different. It is whether triple bottoms should be permitted on the highway system of a specific State. In this case, if single bottoms are employed, the fatalities to move 100 million ton-miles of freight would be 0.38 as shown in the hypothetical example in Table 1. If triple bottoms are permitted in lieu of single bottoms (triples are now permitted, at least to some extent, in 7 States), it is possible that some diversion of freight from rail to truck would occur. If there is 10 percent diversion, the number of fatalities would be 0.322, a substantial reduction. That value is arrived at by the following process: the diverted shipments would have associated with them 0.31 fatalities for triple bottoms rather than 0.19 fatalities for rail - a net increase of 0.12 fatalities per 100 million ton-miles or 0.012 fatalities for the diverted portion (10 million ton-miles). Thus for 10 percent diversion, the result would be an overall net fatality rate for shipment by triple bottoms of 0.31 plus 0.012 equals 0.322, rounded to 0.32 as shown in Table 1. A diversion of 60 percent from rail is required before the combined net fatality rate of triples (with diversion) equals that of single bottoms.

Other Considerations

A more complete way of comparing freight movement would require stratifying shipments by commodity class; by density of each class of commodity; by consideration of specific points of origin and destination; and by alternative truck configurations and alternative modes, particularly rail. Such comparisons, however, are difficult to accomplish and may not justify the additional effort. The use of reasonable estimates of ton-mile accident and fatality rates coupled with estimates of diversion from other modes may be sufficient for many purposes.

It should be emphasized that use of exposure information for accident and fatality rate comparisons are only one aspect of the problem posed for decisionmakers. Economic, environmental, energy, and other considerations are also of considerable consequence. Fuel consumed per ton-mile, for example, is useful in comparing singles vs. triples or truck vs. rail. Here, too, the diversion issue is important and may be handled in a similar fashion to the hypothetical example shown in Table 1. Accident rates, of course, are also useful in economic analysis because the economic consequences of accidents is considerable totaling between 20 and 40 billion dollars yearly depending upon the method of computing such costs and averaging about 2¢ or 3¢ per vehicle mile for all vehicles. Such costs are substantially greater for trucks where - although the truck-mile accident rate is lower than for passenger cars - severity of each accident is greater, there are more fatalities per accident and some shipments are very valuable. The limiting case is the transport of extremely hazardous materials where more expensive packaging is used to cushion and insulate the materials and minimize the risk and many other precautions are taken as indicated earlier.

Another consideration is local versus long distance transport of materials. Thus, around cities there is little opportunity to transport freight by air or rail; in most instances trucks haul nearly all local shipments. Thus, decisions and comparisons involve vehicle-mile rates and ton-mile rates for different commodity types on different types of trucks using city streets, freeways, and other types of urban highways. Specific routes from origin to destination need to be considered.

Conclusion

With respect to freight movement, accident and fatality rates based on vehicle-miles are sufficient for some decisions relative to safety, economic, environmental, and other issues. For other and often more critical decisions, rates need to be based on ton-miles. In some instances, the calculations also need to consider other issues such as diversion from rail to trucks, the type of commodity shipped, the density of the commodity, and the value of the commodity shipped. Other factors include the type of highway employed, time of day, and intercity vs. local hauls. These freight oriented exposure methods and considerations coupled with related accident, energy, exhaust emission, and cost information will aid in decisionmaking including such controversial questions as to whether and under what conditions heavier and larger trucks should be permitted to operate on the Nation's highway systems.

Table 1: Hypothetical Example of Alternative Methods of Transporting Grain

Problem: Determine relative safety of hauling 100,000 tons of grain from Paris, Kansas, to Peking, Pennsylvania, a distance of 1,000 miles, by various transportation modes.

	Number per 100 million vehicle-miles		Number per 100 million ton-miles	
Mode	Accidents	Fatalities	Accidents	Fatalities
Trucks				
Single bottoms	146	3.8	14.7	0.38
Double bottoms	149	5.3	11.0	0.40
Triple bottoms	160	6.0	8.0	0.31
Rail			4.9	0.19
Combined Net Rates for Triples with following diversion from rail:				
10 percent			8.3	0.32
30 percent			8.9	0.35
60 percent			9.4	0.37

SESSION V

Investigation of Direct and Indirect Commercial Vehicle Exposure Estimation Methods

Lloyd Philipson
Institute for Safety and System Management
University of Southern California

Data Collection Procedures for Truck Exposure

Fred Hanscom
BioTechnology, Inc.

Feasibility Investigation of Two Commercial Vehicle Exposure Estimation Methods

by

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Abstract

The feasibility of two distinct methods of commercial vehicle exposure estimation is investigated, employing sample data from two areas of California during 1975-76. The first, simple in principle but rather complicated in its details, is a "direct" estimation process using observed traffic and truck weight observational data. The second is an "indirect" estimation process that infers exposure from observed accident data. Neither process can yet be considered adequate; moreover, their results are not very comparable. However, the exhibtion of the two methods makes clear their strengths and weaknesses, and provides a useful framework on which to build an improved estimation capability.

FEASIBILITY INVESTIGATION OF TWO COMMERCIAL VEHICLE EXPOSURE ESTIMATION METHODS

Prepared for the

Symposium on Commercial Truck Exposure Estimates

9-11 April 1979
Washington, D.C.

by

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and

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FEASIBILITY INVESTIGATION OF TWO COMMERCIAL VEHICLE EXPOSURE ESTIMATION METHODS*

ABSTRACT

The feasibility of two distinct methods of commercial vehicle exposure estimation is investigated, employing sample data from two areas of California during 1975-76. The first, simple in principle but rather complicated in its details, is a "direct" estimation process using observed traffic and truck weight observational data. The second is an "indirect" estimation process that infers exposure from observed accident data. Neither process can yet be considered adequate; moreover, their results are not very comparable. However, the exhibition of the two methods makes clear their strengths and weaknesses, and provides a useful framework on which to build an improved estimation capability.

INTRODUCTION

A relatively high frequency of occurrence of some factor in a sample of reported highway or other transportation accidents is an indicator of that factor's possible importance in the "causation" of those accidents. If means ("countermeasures") can be found for eliminating or at least decreasing the potential for harm of the factor, enhanced safety will presumably result. However, before the true importance of the factor, and any major investment for modifying it, are decided upon, it is also essential to determine whether that factor's high frequency of occurrence in accidents is in fact significantly associated with the occurrence of accidents, or whether its occurrence is merely an artifact of "exposure"; that is, it is frequently present in the normal transportation operations of concern, whether or not an accident occurs.

The concept of exposure, its proper definition in various cases, and its introduction into accident analyses have received a great deal of attention in the highway and other transportation safety literature. Chapman (1973) provides a general discussion of, and extensive references to this literature. For the sake of brevity, no additional discussion will be given here.

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In the study from which this article derives (Philipson, 1978), two distinct procedures were established to develop commercial vehicle exposure estimates in terms of vehicle miles travelled (VMT) for various categories of vehicles, and on a road network and during a time period of interest: "direct" and "induced" estimation, respectively. They and their initial results are described in this article. It will be clear in their descriptions that they are both highly approximate and not yet supportive of much confidence in their implications. However, they are believed to make the best possible use of available data, and care has been taken to assure that they fully illuminate this use. They thus establish a useful basis for determining feasible improvements and their associated new data requirements.

THE DIRECT ESTIMATION OF EXPOSURE

Data on commercial vehicle or "truck"* counts categorized by type, number of axles, and weight may be presented as in Table 1. The cell entries are truck volumes counted or extrapolated over a specified time interval and for a specified set of roads. An alternative, more aggregated categorization scheme is by truck type and number of axles only, as is shown in Table 2. Finally, truck count categorization, even more aggregated so as to provide truck volume vs. number of axles only, is shown in Table 3.

Other variables besides truck volume count, such as VMT, will also be entered into tables with these three formats during the course of the estimation process. Tables 1 to 3 should therefore be considered to be generic, to be called upon in different applications as the analysis proceeds.

The data available for the exposure estimation process are:

a) Annual Average Daily Traffic of Trucks categorized only by number of axles (AADTT), presented in a table with the format of Table 3, where the entries are AADTT at a particular road milestone. The road network of present interest consists of the State roads in two zones of the California Highway Patrol (CHP) in the Sacramento and Los Angeles areas (approximately 4,100 total miles).

b) Truck Weight Study Data (TWD), consisting of counts of categories of trucks defined by the cells of a Table 1, where the entries are based on a particular eight-hour observation at a particular weigh station.

c) Truck Weight Study Volume Counts (TVC) similarly consisting of counts of categories defined by the cells of a Table 2, without weight information, where the entries are three combined eight-hour counts at a particular weigh station.

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* Buses are also meant to be included in all references to trucks in this article, except where noted otherwise.

TABLE 1. ENTRIES CATEGORIZED BY TRUCK TYPE, TRUCK CONFIGURATION AND WEIGHT CLASS*

Weight, lb.	Truck Type															
	Single Unit				Tractor + Semi-Trailer				Truck + One Full Trailer				Tractor + Semi-Trailer + Full Trailer			
	No. of Axles				No. of Axles				No. of Axles				No. of Axles			
	Bus	2	3	4+	3	4	5	6+	3	4	5	6+	4	5	6	7+
10,000–25,000																
25,001–60,000																
60,001 +																

*This table is applied with several different entry variables (e.g., truck volume count, VMT

TABLE 2. ENTRIES CATEGORIZED BY TRUCK TYPE AND NUMBER OF AXLES

	Truck Type															
	Single Unit				Tractor + Semi-Trailer				Truck + One Full Trailer				Tractor + Semi-Trailer + Full Trailer			
	No. of Axles				No. of Axles				No. of Axles				No. of Axles			
	Bus	2	3	4+	3	4	5	6+	3	4	5	6+	4	5	6	7+
Entry Variable*							–									

*This table is applied with several different entry variables.

TABLE 3. ENTRIES CATEGORIZED BY NUMBER OF AXLES

	Number of Axles			
	2	3	4	5+
Entry variable*				

*This table is applied with several different entry variables.

These data are developed and reported by state agencies. What is now desired is the derivation from them of the VMT estimates for each cell of a Table 1, over a given road network and during a given period of time. How to obtain these estimates step-by-step, and as well as possible, from a combination of the foregoing data is described next. In the process, the input data and the extrapolation procedures that must be used are critiqued.

The steps to be described roughly involve accomplishing the following:

a) Development of the input observational data on vehicle category counts for given hours of observation, and at given highway milestones and weigh stations.

b) Extrapolations to 24-hour such counts.

c) Estimation of VMT implied by these counts and known lengths of road where they are assumed to apply, for given road networks and a time period of interest.

The Development of AADTT Data

The California Department of Transportation (CALTRANS) conducts truck and bus traffic volume counts at the mileposts and other locations on the entire network of State highways. The AADTT data produced consist of estimated truck volumes for all count locations. Trucks are categorized by number of axles. Buses are considered separately. The truck volumes listed are combined from counts for both directions at an observation location.

CALTRANS' truck count data collection procedure is based on visual observati ... A data collector is stationed at the side of the highway or freeway at a specified count site, usually at a milepost. Mileposts are usually at intersections or freeway entrances or exits. He counts the number of vehicles and categorizes them as buses or as trucks with two, three, four, five, six, and seven axles or more. The accumulated count in one hour is recorded on a special form. These forms also contain information describing the count location, date, time, direction, and milepost leg (the two-way road segment on each side of the milepost).

These volume counts are recorded for six hours only. There are a few locations where volume counts are recorded for 24 hours. A 24-hour volume count is not a continuous record of any one day, however, but consists of three eight-hour counts during three different shifts on different days.

CALTRANS' data processing then consists of (a) adjusting the accumulated six-hour volume for a given leg for trends in traffic volume; (b) adjusting the accumulated six-hour volume of a particular category of vehicle (defined only by number of axles) on the basis of experience and purely subjective judgment; and (c) judgmental expansion of the

six-hour volume to 24 hours. The outcome of the last step is then added to its counterpart for the opposite direction, to provide the total estimate for the leg. The total is rounded up to the nearest 10, and the outcome is the published AADTT data for each milepost leg.

The Development of the TWD

CALTRANS has conducted the Truck Weight Study yearly.[1] This study involves recording the configuration (i.e., type and number of axles) and weight of each truck that passes through each of a selected set of weigh stations during an eight-hour period, and also counting the truck flow past each location for a total of 24 hours. No attempt is made to select weigh stations so as to assure a representative sampling of the truck population. Table 4 lists the locations of the weigh stations involved in the present analysis.

The data collection procedure is as follows:

a) For a 15-20-minute period, trucks in a certain type/number of axles category are directed to the weigh station. For successive periods, different truck categories are weighed and counted. Trucks with unusual configurations, such as construction trucks, always go through the station and are counted (except when (b), below, obtains).

b) Should the weighing queue become long, the operators, using their discretion, direct incoming trucks to bypass the weigh station and continue on their way. No effort is made to avoid any bias in the obtained data for different truck categories that might result from this.

This data collection operation continues for a block of eight hours. The starting time may vary at different weigh stations.

In this way a table with the format of a Table 1 for the counts of weighed trucks is constructed for an eight-hour period at a given weigh station. To establish a Table 1 for a 24-hour period, extrapolation is required, as next described.

Truck Characteristics Estimates

The CALTRANS team also records truck traffic volume counts (TVC) at each station for each type/number of axles (but not weight) configuration for three different eight-hour periods, covering a combined 24-hour period. The eight-hour periods are not consecutive, however. They are established during three different days during the year. (Little effort is made to avoid day-of-the-week or seasonal biases; however, the spreading of the three observation periods is no doubt of some value in this.) A Table 2 is then constructed for each such 24-hour TVC by adding the three eight-hour counts. These results

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[1] The study is now conducted only biennially.

TABLE 4. TRUCK WEIGHT STUDY LOCATIONS IN OR NEAR ZONES II AND V

Zone	Station Name	Highway	1974-1975	1975-1976
II	Antelope	I-80	x	
	Camino	ED-50	x	x
	Cottonwood	I-5	x	
	Livermore	I-580	x	
	Livingston	SR-99	x	
	San Luis*	SR-152	x	
V	Banning	I-10	x	
	Cajon	I-15	x	
	Carson	I-405	x	x
	Castaic	I-5	x	x
	Conejo	US-101	x	
	Fontana	I-10	x	
	Peralta	SR-91	x	x
	San Onofre	I-5	x	
	Wheeler Ridge	I-5	x	

*Portable scale site.

essentially complete CALTRANS' contribution to the present study. To extrapolate CALTRANS' results to VMT estimates, the analysis continues as follows.

Twenty-four-hour truck volume estimates at each given weigh station, in terms of weight, type, and number of axles, are first obtained from the completed eight-hour TWD Table 1 and the 24-hour TVC Table 2 by a simple linear extrapolation process. A Truck Characteristics Table (TCT), also with the cells of a Table 1, but with entries now being estimated counts for a 24-hour period, is thereby established. The linear expansion coefficients are the ratios of the 24-hour TVC Table 2, to a Table 2 obtained from the aggregation of the eight-hour TWD Table 1 over weight classes. Each column of the eight-hour TWD table is then multiplied by the corresponding ratio, and a 24-hour TCT with the format of a Table 1 is obtained.

The foregoing process of obtaining truck characteristics estimates was applied to data derived during 1975 at each of six weigh stations in or near California Highway Patrol (CHP) Zone II (near Sacramento), and nine stations in or near Zone V (near Los Angeles), as shown in Table 4. The CHP accident reports providing the accident data base for the study which this article describe in part, also derived from these zones (Philipson, 1978).

A TCT of 24-hour truck characteristics estimates may be obtained in this way for any location where TWD and TVC are available. The objective now is to estimate from the TCT's for these particular locations the truck characteristics volume estimates for each entire CHP Zone.

The 24-hour volumes assumed to apply to each entire zone are estimated by averaging the truck characteristics counts that are available at all of the weigh stations associated with the zone, assuming (without any verification as yet) that truck traffic at the stations provides a representative sample for the zone. For example, 24-hour truck characteristics volumes for each zone in 1975 are estimated by averaging the six TCT's for Zone II and nine TCT's for Zone V, respectively.

This approach is less satisfactory in the case of the 1976 TWD, however, because in that period there were only one TCT location for Zone II and three TCT locations for Zone V. A modified approach is therefore necessary for obtaining the Zones' TCT's for 1976. It remains the same as for 1975 up to the 24-hour TCT calculation. At this point, however, the ratio between the 24-hour TCT of 1975 and that of 1976 is found for each common location. The 1976 TCT for the entire Zone II is then obtained by adjusting the 1975 TCT by the Zone II location's ratio, and for Zone V, by the average of its three locations' ratios.

VMT Estimates

The milestone AADTT data described earlier enable the computation of VMT vs. number of axles only (a Table 3), as will next be seen. The combination of the results with the Table 1 TCT data just derived,

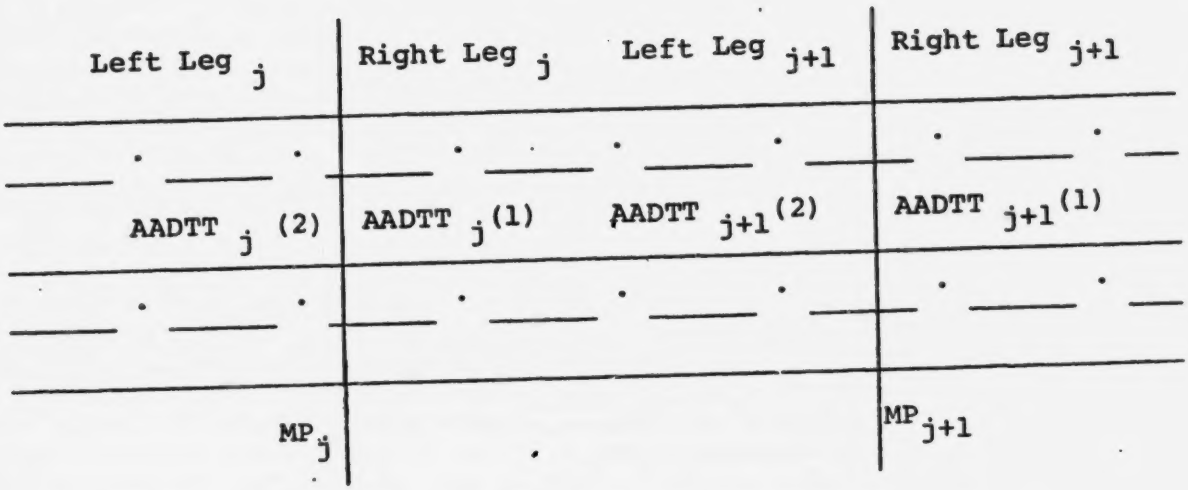

FIGURE 4. VMT CALCULATION PARAMETERS

via linear extrapolation, then allows the development of VMT estimates vs. type and weight as well, the final desired Table 1. The process is as follows:

Basic VMT Estimates from AADTT Data

The VMT estimation procedure begins with the generation of a Table 3 of VMT estimates for a given section of highway. This is obtained by adding VMT's estimated from AADTT data (also given in Table 3's) for the two legs of each adjacent milepost contained in that section. These VMT estimates derive from the milestone AADTT counts data and the known road miles between the milestones.

First, one writes

$$VMT = \sum_{j=1}^{n} VMT_j \qquad (1)$$

where VMT is the vehicle miles travelled (for a vehicle category with a given number of axles) for a given section; VMT_j is the vehicle miles travelled between two adjacent mileposts in the section, j and j + 1; and n is the number of mileposts within the section.

VMT_j can be calculated in terms of the volume counts at two mileposts and the distance between them. The approximation

$$VMT_j = 1/2\ (AADTT/A_j(1) + AADTT/A_{j+1}(2)) \cdot (MP_{j+1}-MP_j) \qquad (2)$$

is employed, where $AADTT_j(i)$ is Annual Average Daily Traffic by number of axles at the jth count location, right leg (i = 1) or left leg (i = 2), established for a 24-hour period from the six-hour data, for 1975 and 1976, respectively, as previously described. MP_j is the milepost's index, increasing with j, so $MP_{j+1}-MP_j$ is the distance in miles between mileposts j+1 and j. Figure 1 shows the parameters associated with the above formula. Note that the averaging of AADTT over the corresponding legs of adjacent mileposts assumes that the number of trucks exiting is, on the average, the same as the number of trucks entering at the mileposts in the section of road under study, evidently a questionable, if at present unavoidable, assumption.

Summing over j for each CHP zone, as in Equation (1), then provides the Table 3's, one for each zone, of total VMT vs. number of axles, and for a 24-hour period of each year, that are needed to begin the final extrapolation, described next.

The computations summarized above can be applied to the bulk of the available AADTT data from CALTRANS. In some instances, however, the data deviate slightly from the typical definitions that have been given (e.g., at milestones near zone boundaries). Additional special procedures, not worth going into here, must then be applied to generate supplementary data.

VMT Extrapolation Process

A Table 3 of VMT estimates vs. number of axles has now been established for those portions of the State highway system within CHP Zone II and Zone V, and for the time period of interest.

These VMT estimates vs. number of axles only, are then extrapolated to the desired VMT estimates vs. truck type, axles, and weight (in a Table 1). This extrapolation begins with the following steps:

a) Aggregating each zone's 24-hour average TCT (a Table 1 of volume counts) for 1975 and 1976, respectively, over all weight classes (giving a Table 2).

b) Aggregating further over all columns with equal numbers of axles.

The outcome of this two-step aggregation is a single row table for each of 1975 and 1976, with the format of a Table 3. The entries are 24-hour truck traffic volume counts, categorized by number of axles only, and averaged for each CHP zone.

The estimated 24-hour VMT's from AADTT data (thus vs. number of axles only) for each zone are also arranged in a Table 3. Linear extrapolation coefficients then generate a row table also with a Table 3 format, whose entries are the ratios of corresponding elements of the VMT table to the table obtained in (b) above. This last set of ratios is then applied to the columns of the Table 1 TCT. The outcome is a 24-hour VMT value for each of the cells of a Table 1, for each zone, and for 1975 and 1976, respectively.

Finally, the two zones' 24-hour tables for each year are added together, the results for each year are multiplied by the number of days in the year that are included in the time period of interest, and these results for the two years are added. This provides a Table 1 for the desired total VMT estimate for each truck category, and for the total area and time period of interest. A numerical example of these results is given below, following a review of the sources of inaccuracy and other weaknesses in the process that has been described.

Critique of AADTT Data and TWD Collection and Potential Improvements

AADTT data and TWD shortcomings are reviewed first, and some means for improving them, and therefore the VMT estimation process, are described.

AADTT Data Shortcomings

AADTT data are collected and processed by CALTRANS. The following are some points of concern.

a) Observing the passing trucks and counting the number of axles at the same time is not an easy task. There are no concrete estimates of associated errors. A sampling study involving redundancy checks would enable assessments of these errors and their distributions.

b) The subjective adjustment factor in extrapolating from six-hour to 24-hour traffic volume estimates, that compensates for the unobserved traffic in early morning or late night hours, is based mainly on past years' data. The dynamic nature of the highway system and the industries it supports clearly can introduce new factors in the daily distribution of trucks on the highway system. A more justified adjustment factor would provide a major improvement in the quality of the extrapolation.

c) AADTT values from the year before are similarly used to expand the specific days' observational data to average daily counts for the present year. In compensating for trends in truck volume, values from the year before are used again. On occasion subjective views are also of significance. While this approach is convenient, and reasonable estimates may perhaps be made in the case of gradual changes in truck traffic, there is a danger that sharper changes are not well accounted for. For example, the rapid change in fuel costs, the increase of load limit per axle, and recent significant variations in the economy, have probably caused important variations in truck volume not fully accounted for.

d) Another similar adjustment made by CALTRANS occurs when the expanded and interpolated value for truck volume at each location is compared with its counterpart from the year before. If the difference is too high, the figure for the current year is changed so that it is closer to the number from the preceding year. While replacing a count with another number based on the previous year may compensate for gross errors, it ignores the possibility that an actual significant increase or decrease in truck volume may in fact exist.

TWD Shortcomings

TWD data are also collected by CALTRANS. This data base consists of two distinct parts. The first part is the data collected at weigh stations where axle weight, total weight, truck type, and truck configuration are recorded for eight hours. The second part is truck volume counts accomplished in three eight-hour shifts. These three eight-hour counts are on different days, but cover a 24-hour period. They are then used to represent the count for one full day.

The following are potential sources of error and bias.

a) It is well known that some trucks bypass the weigh station when they can by driving on parallel roads in the vicinity of the weigh station. Therefore, TWD shows truck traffic as less than true volume. Moreover, a bias toward lower observed weights probably occurs, as drivers who think their trucks may be overweight are more likely to avoid the station.

b) Statewide data collection is conducted in a short period of time. For example, the 1974-75 TWD were collected in the fall of 1974 and the 1975-76 TWD were obtained during the months of April, May, June, and July 1975. Considering the fact that truck traffic on the road is distributed seasonally, short periods of sampling may not result in truly representative counts. For example, the number of auto carriers on the roads is considerably higher in September and October than in July and August.

c) While in the 1974-75 study, 33 weigh stations in the State (including portable stations and the 15 that have been associated with CHP Zones II and V) provided the sites for data collection, TWD were collected at only 16 weigh stations for the 1975-76 study. Truck characteristics data are particularly unreliable for Zone II since TWD were produced at only one weigh station there in 1975-76.

d) As explained previously about TWD collection, trucks of a particular configuration are directed to the weigh station for 15-20 minutes. Trucks with odd configurations, such as construction trucks, always go through the weigh station, except that, finally, should the queue of trucks waiting to be weighed become too long, all trucks are directed past the weigh station for a time. The non-uniform nature of the truck volume distribution over the hours of the day may well cause bias errors in sampling. TWD are collected over a period of eight hours only. In the present process of linear extrapolation and expansion of the eight-hour data into 24-hour data, an inherent assumption was that the mixture of trucks in terms of type and number of axles remains constant. If, as is very likely, the assumption of constant mixture does not hold, more refined 24-hour sampling becomes required.

Impacts of Errors and Improvements

The presence of such errors as have been noted clearly degrades the quality of the data and the methodology of their processing and analysis. The extent of this degradation depends on the almost entirely unknown detailed characteristics of the errors and on their statistical significance. Assessments of these errors via refined sampling procedures is vitally needed. Sensitivity analysis will also shed some light on the potential significance of the possible errors in the various input data elements, and thus on which of these elements it would be most important to try to improve.

The extrapolation process that has been described, requiring repeated aggregation and disaggregation, is needed partly because of the inconsistencies in the AADTT and TWD data sets. This process obviously may propagate errors from one set to the other. The following are typical of means to provide more consistency between TWD and AADTT, and thus diminish these errors.

a) AADTT are collected for six hours, while TWD are collected for eight hours. Unless some adjustments are made (that are basically subjective), the two raw data bases are not comparable. If the AADTT were also collected for eight hours, the comparison of the two raw data

sets would be aided.

b) The comparison in (a) above is more meaningful when the truck classifications are identical in the two sets. Unfortunately, this is not the case. AADTT data give the number of trucks when classified by axles. Revision of the AADTT data acquisition process to cause the counts to be made by truck type as well as number of axles would increase data collection costs, but would be extremely useful.

Numerical Results

The application of the exposure estimation procedure described above leads to the numerical results summarized in Table 5. The table exhibits the estimated VMT for each category of truck configuration and weight (aggregated into three classes for simplicity), for the roads in the two CHP zones of interest, and for the study period of 350 days, 15 May 1975 - 1 May 1976. (This period corresponds to that of the accident reports.)

While the absolute magnitudes of the results cannot be accepted with much confidence, their relative magnitudes appear reasonable. The greatest amount of travel by far appears for the smaller, two-axle trucks; the travel amounts for intermediate-weight three-axle trucks, and for the intermediate-weight five-axle tractor/semi-trailer/full-trailer combinations are each about 40% as large. Five-axle, intermediate-weight tractor/semi-trailer combinations; five-axle, heavy-weight tractor/semi-trailer combinations; and five-axle, heavy-weight tractor/semi-trailer/full trailer combinations fall into the next group in order, each with about 15-20% of the two-axle trucks' VMT.

INDUCED EXPOSURE ESTIMATION

In 1964, J.D. Thorpe (1964, 1967) suggested a procedure for, in effect, estimating the relative exposure of classes of vehicle-driver combinations using only accident report data. This procedure has since been termed "induced exposure" estimation.

Its basis is as follows: Consider a class of vehicle-driver units (e.g., commercial vehicles) on a given set of roads and driving a given period of time. Let the class be made up of a set of subclasses or categories of such units with specified combinations of characteristics of interest (e.g., vehicle type, number of axles, and weight). Let F_i be the fraction of all units in the class that are in the subclass with the combination of characteristics i. Let A be the number of all accidents involving one of the units of the given overall class and one other kind of vehicle not in the class (e.g., commercial vehicle/automobile accidents), and in which the unit in the class is not responsible. Let A_i be the fraction of all such accidents in which the units in the subclass with the combination of characteristics i are involved.

Then the basic induced exposure assumption is that an estimate

TABLE 5. DIRECT EXPOSURE ESTIMATES (VMT) BY COMMERCIAL VEHICLE CATEGORY (MILLIONS OF MILES)

Weight, lb.	Truck Type															
	Single Unit				Tractor + Semi-Trailer				Truck + One Full Trailer				Tractor + Semi-Trailer + Full Trailer			
	No. of Axles				No. of Axles				No. of Axles				No. of Axles			
	Bus	2	3	4+	3	4	5	6+	3	4	5	6+	4	5	6	7+
10,000–25,000	0	798.4	113.1	0	55	7	9.4	0.3	14.9	9.7	6.7	0	0	15.9	0	C
25,001–60,000	16.8	16.5	405	0	89.5	50.2	155.5	0.4	0.5	14.7	19.4	1.0	0.1	303.2	3.3	0.1
60,001 +	0	0	0	0	0	0.3	143.6	0	0.2	0.1	52.7	1.7	0	118.4	4.9	0.2

Total VMT = 2,429

of F_i is A_i/A, enabling the inference of F_i from accident reports data only. Generally, the procedure also requires first estimating the fraction of accidents in which the given subclass i is responsible, by assuming it is the same as the fraction of all single-vehicle accidents in which subclass i is involved. (This assumption has been particularly difficult to justify.)

Once F_i is estimated, various measures of exposure can be calculated. Vehicle miles traveled by subclass i, on the given roads and during the given time, for instance, is estimated as F_i times the total VMT of the overall class. This total, in turn, can generally be estimated, more or less well, from registration or gasoline sales data, or other such information. (Alternatively, the use only of the ratios of different F_i's permits the analysis of the relative involvements of the different combinations.)

In Haight's terminology (Haight 1971, 1973), a simpler "quasi-induced" exposure estimate is possible if the accident records already determine the responsible vehicle in each accident. Then the second assumption above is unnecessary. This simpler procedure is the one employed here, since the present accident data source, the CHP commercial vehicle accident reports, do usually include the identification by the CHP officer of the responsible party in each reported accident. A "subclass" is now a specific commercial vehicle or truck "category," defined by a particular combination of vehicle type, number of axles, and weight characteristics.

It is to be appreciated that if an induced exposure estimation process could be decided to be reasonably valid, in principle it would permit estimates of exposure of any category of truck for which non-responsible accidents are reported. Thus, any set of characteristics of the vehicle, driver, road, and environment that are described in the accident reports could be considered, in principle, as a category or combination of interest. The simple exposure estimation process would proceed for the several categories as has been described. Of course, however, the process would be limited in actual practice by sparse data concerns as category definitions became more complex, and thus fewer accident cases could be found for each one.

Outline for the Simplified Procedure

a) Define A = Total number of truck accidents in the reports file in which (i) exactly two vehicles, one of which is a truck in a category of interest, and one a car or other non-commercial vehicle, are involved, (ii) the responsible vehicle is identified, and (iii) the commercial vehicle is not responsible. (Accident reports are derived from two given CHP Zones for a given period of time, as has been described earlier.)

Assume A represents a sample of all accidents involving a truck, random over all truck categories (described by configuration and weight; other descriptive factors in the accident reports could be added.) Also assume that all neglected accidents (unidentified responsibility; single vehicle; three or more vehicles; two vehicles, both of which are trucks; unreported accident) involve each category of truck in the same proportion as in the car/truck accidents that are considered.

b) Define A_i = Number of the A accidents for which truck category i is involved and identified as not responsible (so $A = \Sigma_i A_i$).

c) Fundamental Assumption of Induced Exposure Estimation: Define F_i = fraction of the A accidents given by $F_i = A_i/A$. Then assume also that F_i = fraction of all trucks (in all categories considered) operating at any time in the given CHP Zones, and during the given time period, that are category i.

Note that this assumption is equivalent to that of all trucks operating in a random "stream" in the highways network, with each truck category having a frequency of non-responsible involvement in an accident simply proportional to the number of trucks in that category. Differences in truck characteristics among the categories therefore are assumed to have no effect on the probability of non-responsible involvement of a truck in an accident. The non-responsible accident involvement process is in fact assumed to be a simple Bernoulli process, with a fixed accident probability for every truck, on the given road network and for the given period of time.

d) Define VMT_{Total} = Total vehicle miles travelled by all the categories of trucks in the two given CHP Zones and the given time period. In the present analysis, this is estimated as the total given by the direct exposure estimation process delineated earlier.

Then $VMT_i = F_i \times VMT_{Total}$ is the induced exposure estimate for the ith truck category.

Numerical Estimates

Tables 6, 7, and 8 present the steps of the induced exposure estimation process. The first table exhibits in each cell A_i, the number of two-vehicle accidents involving one commercial and one non-commercial vehicle, with the commercial vehicle judged by the CHP to be not responsible for the accident; the number of such accidents in which the commercial vehicle is judged responsible; and the number of such accidents where responsibility was not assigned. These numbers, determined for each of the truck categories by a cross-tabulation from the accident reports data base of the study from which this article derives (Philipson 1978), are the inputs for the estimation process. Buses have been deleted in this to avoid some complexities in the cross-tabulation procedure.

TABLE 6. NUMERICAL VALUES OF ACCIDENT COUNTS VERSUS RESPONSIBILITY AND TRUCK CATEGORY

Weight, lb.		Truck Type															
		Single Unit				Tractor + Semi-Trailer				Truck + One Full Trailer				Tractor + Semi-Trailer + Full Trailer			
		No. of Axles				No. of Axles				No. of Axles				No. of Axles			
	Bus	2	3	4+		3	4	5	6+	3	4	5	6+	4	5	6	7+
10,000–25,000		117	33	0		17	16	33	0	2	4	14	0	0	17	0	0
	ND	179	62	0		27	33	47	2	3	11	17	1	0	34	6	0
		10	3	0		4	5	8	0	0	0	4	0	0	3	0	0
25,001–60,000		12	17	0		15	19	98	1	0	3	13	1	0	71	16	3
	ND	38	36	0		17	26	138	2	1	2	21	2	0	89	11	3
		1	5	0		4	4	15	0	0	0	6	0	0	11	0	1
60,001 +		2	2	0		0	3	71	0	0	1	26	1	0	61	0	0
	ND	6	1	2		2	7	123	3	0	1	49	0	0	92	8	2
		1	0	0		1	1	11	0	0	0	8	0	0	9	0	1

ND = Not Determined.

Key: Not Responsible
Responsible
Unknown

TABLE 7. F_i RATIOS FOR INDUCED EXPOSURE ESTIMATES

Weight, lb.	Truck Type															
	Single Unit				Tractor + Semi-Trailer				Truck + One Full Trailer				Tractor + Semi-Trailer + Full Trailer			
	No. of Axles				No. of Axles				No. of Axles				No. of Axles			
	Bus	2	3	4+	3	4	5	6+	3	4	5	6+	4	5	6	7+
10,000–25,000	ND	0.1698	0.0479	0	.0247	.0232	.0479	0	.0029	.0058	.0203	0	0	.0247	0	0
25,001–60,000	ND	0.0174	0.0247	0	.0218	.0276	.1422	.0015	0	.0044	.0188	.0015	0	.1030	.0232	.0044
60,001 +	ND	0.0029	0.0029	0	0	.0044	.1031	0	0	.0015	.0377	.0015	0	.0885	0	0

ND = Not Determined.

TABLE 8. INDUCED EXPOSURE ESTIMATES (VMT, MILLIONS OF MILES)

Weight, lb.	Truck Type															
	Single Unit				Tractor + Semi-Trailer				Truck + One Full Trailer				Tractor + Semi-Trailer + Full Trailer			
	No. of Axles				No. of Axles				No. of Axles				No. of Axles			
	Bus	2	3	4+	3	4	5	6+	3	4	5	6+	4	5	6	7+
10,000–25,000	ND	409.5	115.5	0	60	56	115.5	0	7.0	14.0	49	0	0	60	0	0
25,001–60,000	ND	42.0	60	0	52.6	66.6	343	3.6	0	10.6	45.3	3.6	0	248.4	56	10.6
60,001 +	ND	7	7	0	0	10.6	248.6	0	0	3.6	91.0	3.6	0	213.4	0	0

ND = Not Determined

Total VMT = 2,412
(Exclusive of Buses)

Table 7 shows the resulting $F_i = A_i/A$ ratios, where A is the total over the cells of the number of accidents.

Table 8 then exhibits the estimated VMT values for the 45 commercial vehicle categories. The values are obtained as F_i times the total VMT for all these categories. The total VMT used here, 2,412 million miles,[1] is that established in the direct estimation process (see Table 5).

As with the direct estimates, the absolute magnitudes of the results are of very uncertain accuracy. Moreover, they generally differ substantially from the direct estimates despite the fact that their totals are the same. Nevertheless, the relative values of the induced estimates are not entirely unreasonable.

CONCLUSIONS

Clearly, there is no present way to assess which of the two methods - direct or induced estimation - is more accurate, or, more importantly, what the level of accuracy is. The presentation in this article of the two methods in very full detail is intended, however, to aid these assessments in the future. Extending from the limited basis provided in this article, means can be sought for improving the direct estimation process through improved AADTT data and TWD acquisition procedures; the development of additional data for augmenting these data, such as more detailed and better controlled special samples; and the development of improved extrapolation procedures. The induced estimation procedure may also be improvable by attempting to generalize its very arguable assumption on the equality of the probability of accident involvement for all individual trucks, and, most particularly, its assumption on the equality of the fraction of non-responsible accident involvements and the fraction of the total truck population represented by each truck category. To the extent that it can be accepted, the induced procedure can provide a vehicle for validating the direct estimates, and perhaps, aiding their disaggregation into exposure estimates for more detailed driver-vehicle characteristics.

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[1] Excluding the 16.8 million miles estimated by the direct process for buses.

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ABSTRACT

Data Collection Procedures for Truck Exposure

by

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This paper discusses four methods applied in an FHWA study (DOT-FH-11-8835) to gather truck exposure data. The methods range from gross visual information elicited from time-lapse film to precise operational characteristics gathered from electronic timing of vehicles via roadswitch sensors. A random sampling technique was employed to eliminate the possibility of site selection bias. The sample includes data gathered at 78 sites in 6 states.

Specifically, the four collection methods are as follows:

1. Time-lapse photography. Single frame pictures of randomly selected vehicles: frame exposure frequency was based on volume. Twenty-four hour surveillance was maintained via an electro-mechanical counter attached to a roadside tapeswitch. The purpose of this procedure was to determine the representation of various truck types as a proportion of overall traffic volume.

2. Manual counting. Visual coding of vehicles in traffic streams to ascertain exposure data as described above. This procedure was used as a back-up for the automatic time-lapse counting technique.

3. Survey. Gathered for samples of trucks at weigh stations, etc., these extensive data included truck configuration, driver characteristics, loading, weight, length, width, and engine characteristics.

4. Traffic Evaluator System. Precise operational data were obtained for twenty-four hour periods at 12 locations in Michigan, Nevada, and California.

Data Collection Procedures for Truck Exposure

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Prepared for the

National Symposium on
Commercial Truck Exposure

9-11 April 1979
Washington, DC

INTRODUCTION

This paper describes three methods to gather truck exposure data which were applied in a recent FHWA study (DOT-FH-11-8835). The overall objective of the study was to determine the impact of size and weight increases on highway safety. "Truck exposure" was the term used to describe the number of trucks currently in use and the annual number of miles these vehicles are driven. Determination of exposure for the various truck types provides a basis for analysis to determine if any particular class of truck is over- or under-involved in accidents in relation to its occurrence on the highway sytem.

Three types of exposure data were collected in the study. The first type was a 24-hour sample of traffic operations obtained using the Traffic Evaluator System. This device consists of electronic roadway sensors and ultimately derives precise flow data using a computer. The remaining exposure data types were used to complement the study's accident data. The second type yielded miles of travel and was collected using film sampling and manual count technique of all vehicles traveling through the study sites for a one-week period during each of the six study quarters. The third type of exposure data obtained truck information which was unavailable from the film analysis or manual count; i.e., truck weight, dimensions, configuration, engine and driver characteristics. This information was gathered at truck fuel stations, rest stops, and weigh scales within, or in close proximity to, the highway segments in the study.

A stratified random sampling technique was used to select 79 roadway segments where data were collected. These segments comprised approximately 1066 miles (1713 kilometers) of highway in six states. A roadway typology partitioned these segments into six exclusive types. Two classification variables were used: highway location (rural and urban), and highway type (freeway, primary, and secondary).

The three applied techniques (i.e., Traffic Evaluator System, time lapse photography, and surveys) to gather exposure data, are separately discussed.

Traffic Evaluator System

Description

The Traffic Evaluator System (TES) was developed in 1969 by the Federal Highway Administration to facilitate the large-scale collection of traffic flow data. Major components of the TES include:

- An array of tapeswitches that transmit an electrical pulse when vehicle presence is detected (input).
- An electronic coding unit, a digital tape recorder, and an electronic clock.
- A series of computer programs that reconstruct the actions of the vehicles and prepare descriptive and inferential statistics.

The TES is a portable, battery-operated research tool that continuously monitors 60 switch contacts. While most of the contacts are usually used for the tire detector switches, the remainder can be used for manual event coding.

The operation of the TES depends on the pressure of vehicle wheels, which is sensed by tapeswitch closures. Upon activation of any switch contact, the time of initial closure and the identification number of the active switch are recorded on a seven-track computer tape. The processing of these data tapes can yield the following measures for each vehicle passing through the array: lane changes, velocity, relative speed, headway, gap, acceleration, number of axles, and wheelbase.

Wheelbase and number of axles are, of course, constant for a given vehicle traversing the tapeswitch aeeay. However, each of the other measures is generated at a number of points along the highway, depending on the position of the tapeswitches and their distance from a selected point of interest such as an interchange gore area. The data can also be aggregated to yield summary statistics such as the number of vehicles in each lane, mean speed, and mean headway.

The TES is the property of the Federal Highway Administration. Complete information on the system, including hardware, software listings, and a complete description of the use of the system to collect traffic conflicts data, is

contained in *Appendices A* and *B* of *Part 2, Volume III: Traffic Engineering Evaluation of Diagrammatic Guide Signs, Diagrammatic Guide Signs for Use on Controlled Access Highways, Report No. FHWA-RD-73-25*, available from the National Technical Information Service, Springfield, Virginia 22151.

Deployment of the TES

Fourteen sites were deployed to gather operational and exposure data. In general, each site was deployed with six switchpairs at 300-ft. intervals. Each switchpair consisted of two parallel switches spaced four feet apart. At sites where a measure of lateral placement was obtained, diagonal switches were included at appropriate switchpair locations. A typical tapeswitch array is illustrated in Figure 1.

The number of switchpairs varied between sites. At certain locations where high traffic volumes resulted in a hazardous traffic diversion during the deployment procedure, only one switchpair was used. The distribution of these "single pair" sites was such that a full (six switchpair) array was always deployed at another site nearby in order to avoid major data gaps in any specific geographic area or roadway geometric situation. One site that required extensive flow profile data in a two-lane passing situation was deployed using an .8-mile long, eleven-switchpair configuration in both directions of traffic flow.

Deploying the TES in the field required considerable cooperation from local highway agencies, due to the necessity of stopping or diverting traffic. To deploy a switchpair required the complete stoppage of traffic in each lane for a period of spproximately five minutes. This time is required for technicians to perform necessary measurements and tape applications to the pavement. Traffic control assistance was obtained from highway departments in Michigan and California and from police agencies in Virginia and Nevada so that the deployment could be carried out.

Field Operation of the TES

Although the TES runs continuously without manual operation, manual coding of trucks and simuntaneous triggering of a time-lapse camera was one facet of its operation in this study. Coding of trucks in the traffic stream facilitated the isolation of their performance data within the continuous record of data for the entire stream. Concurrent filming of the traffic stream with a time-lapse camera provided a pictorial description of the truck for the purpose of visually matching weight data.

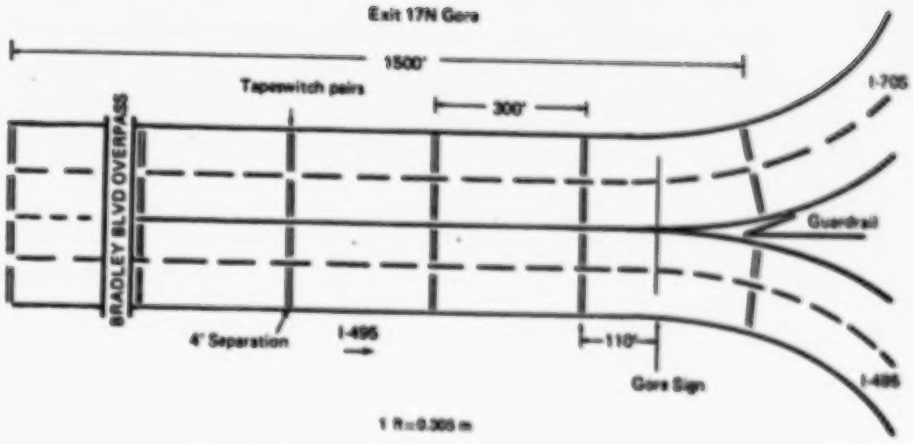


Figure 1. Typical array for deployment of TES tapeswitches (Exit 17, Northbound, on I-495 in Maryland).

Automatic Time-Lapse Sampling

This technique consists of a time-lapse camera which is automatically triggered by a roadswitch sensor. The remotely-controlled camera is located at a convenient distance from the highway in order to provide a suitable field of view and to afford some protection from vandalism. Pictorial data supplied by Super-8mm film are used to visually identify selected vehicles which activate the roadswitch. The sensing apparatus samples axles passing the roadswitch and triggers the camera to expose a single frame when a specified axle count is reached. The number of axles to be detected between exposures is dependent upon site-specific traffic volumes. This number is set so that one roll of Super-8mm film (3600 exposures) will provide a full week of coverage. Final vehicle counts are then based on the observed distributions of vehicles of varying axle configuration. The system as it was deployed in the field is illustrated in Figure 2. Specific components of the system are now briefly discussed.

Roadswitch Sensor

A stainless steel shielded coaxial cable, 1/8" in diameter, was attached to the pavement surface using a rubber based asphaltic compound. The cable had the characteristic of generating a single noise pulse in response to traumatic deformation. A single roadswitch was capable of withstanding high traffic volumes for the week-long period.

Roadside Signal Transmitter

The roadswitch sensor was connected to a sealed metalic box, unobtrusively located near the roadway shoulder. This device, affectionately dubbed the "now" box, transmitted a signal to the camera's receiver when it was time for another exposure. Roadswitch pulses were received and decoded within a noise filter. The desired axle count required between camera exposures was manually set on a counter. When the selected pulse count was reached, a 72 MHZ signal was transmitted to the receiver at the camera location. A 1000 cycle tone was utilized so as to prevent interference from other radio stations.

Camera Housing

The dual problem of camera obtrusiveness and potential vandalism was solved by building fake birdhouses in which to enclose the time-lapse camera and signal receiver. These

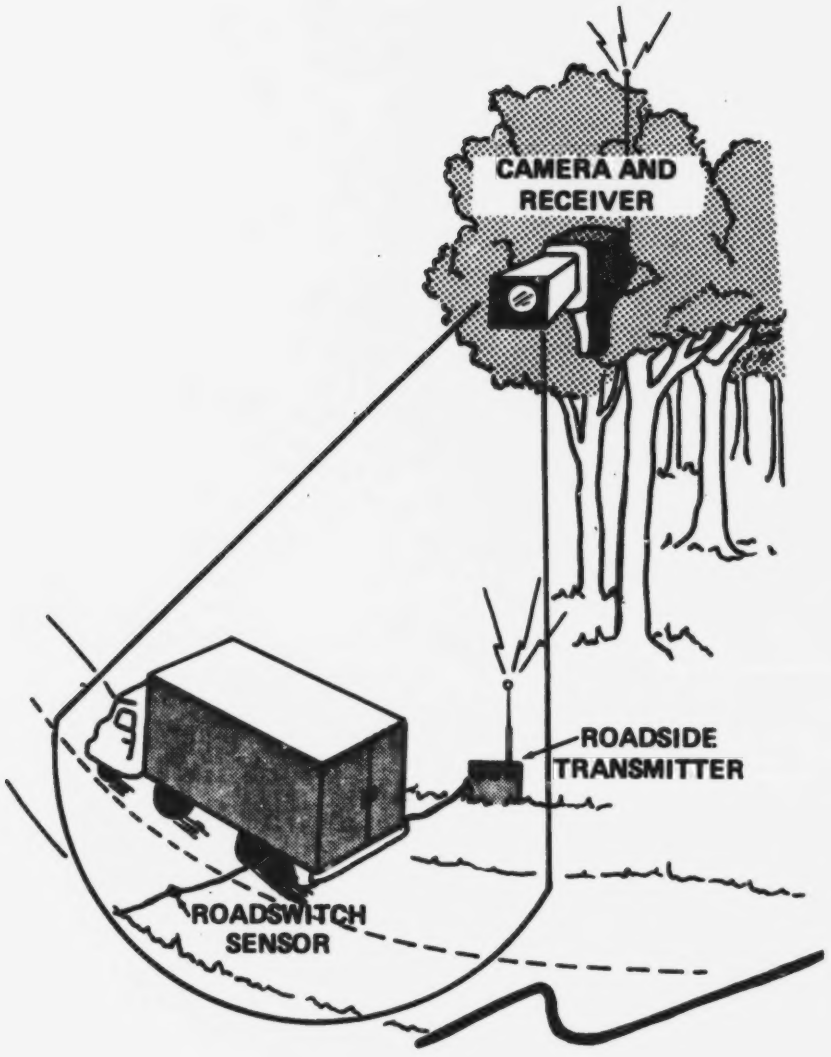


Figure 2. Illustration of Timelapse Camera System components and camera's field of view.

units were mounted in trees, on telephone poles, etc. in proximity to the highway. The time-lapse camera was focused at "infinity" and the zoom lens was adjusted to the appropriate field of view prior to mounting the camera in the birdhouse. Once in the birdhouse, the camera was positioned by sighting along one edge of the house. Naturally, to protect the equipment from real birds who may not possess an inherent appreciation for research, the entrance of the house was covered with glass. Another design feature, also likely to be scorned by Audubon Society enthusiasts, was that no perch was used at the entrance in order to ensure an unobstrcted camera view of the highway.

Camera

Requirements of the utilized camera were: (1) an electronic shutter release (due to excessive power needed for a mechanical release), (2) automatic exposure compensation capability, and (3) sufficient field of view to photograph 150 feet of roadway. A modified Minolta Super-8 camera, model XL-400, was selected to meet these requirements. The zoom lens ranges from 8.5mm to 35mm. The automatic metering system can close the lens to less than F44 or open it to a maximum of F1.2. The electronic shutter may be set for single frame operation. Modification of the camera was required so that a 1200 ASA film was properly exposed using the camera's metering system. An extremely high ASA was required to permit nighttime sampling. Several films were evaluated, and that selected was Kodak 4X black and white movie film rated and processed to yield an ASA of 1200.

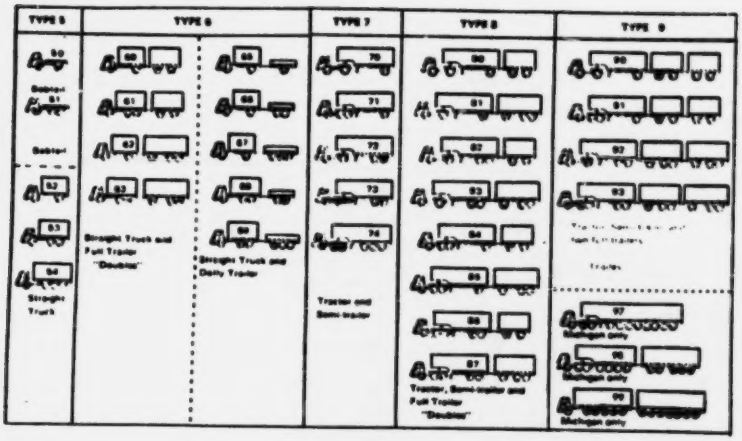
Survey

Certain required truck characteristic data which could not be ascertained via film was gathered using a driver survey.

Size and weight data were collected at several types of locations: weigh stations, truck stops, rest areas, and toll booths. Figure 3 shows the form used in the field to record the information. Data on 15 trucks can be recorded on each page of the form.

Data on 34 separate items were collected, when feasible. These can be grouped as follows:

25-26. TRUCK TYPE



LARGE TRUCK SIZE AND WEIGHT

27. TRACTOR/CAB CONFIGURATION:

0. Not applicable: straight truck
1. Cab behind engine/short hitch
2. Cab over engine/short hitch
3. Cab behind engine/dromedary
4. Cab over engine/dromedary

28-29, 30-31, 32-33. TRUCK/TRAILER CONFIGURATION:

99. Unknown
00. Not applicable: no trailer
01. Fully enclosed
02. Fully enclosed low-bed
03. Tank
04. Bulk commodity
05. Pole, pipe, logging
06. Platform
07. Low-bed, heavy hauler
08. Dump
09. Auto carrier
10. Pole (Dolly type)
11. Dolly
12. Mobile home
13. Saddle mount

Site #			Quarter	Day of Week	Hour	Direction	Truck Type	Configuration					5th Wheel Loc.	Tractor/Truck Make	Oversized Load
								Tractor/Cab	Straight Truck/ Semitrailer	Full/Dolly Trailer #1	Full/Dolly Trailer #2				
1	2	3	4	5											

ACCIDENT STUDY
DATA COLLECTION FORM

Field Investigator _____
Date _____
Place _____
Route _____

5. DAY OF WEEK: 1. Sun. 2. Mon. 3. Tues. 4. Wed. 5. Thurs. 6. Fri. 7. Sat.

24. DIRECTION OF TRAVEL THROUGH SITE: ■. Unknown 1. Northbound 2. Eastbound 3. Southbound 4. Westbound

35-36. TRACTOR/TRUCK MAKE: ■. Unknown 01. Autocar 02. Brockway 03. CCC 04. Chevrolet 05. Diamond Reo 06. Dodge 07. Ford 08. Freightliner 09. Freuhauf 10. GMC 11. International 12. Kenworth 13. Mack 14. Mercedes Benz 15. Peterbilt 16. White 99. Other

37. OVERSIZED LOAD: 0. Not oversized load 1. Wide load 2. Overlength load 3. Overweight load 4. Overheight load

72. ENGINE HORSEPOWER: ■. Unknown 0. <250 HP 1. 251-300 HP 2. 301-350 HP 3. 351-400 HP 4. 401-451 HP 5. 451-500 HP 6. 501-550 HP 7. 551-600 HP 8. 600-650 HP 9. >650 HP

73. DRIVER SE : ■. Unknown 1. Male 2. Female

76. EXPERIENCE AS PROFESSIONAL TRUCK DRIVER: (Use column 77 codes)

77. EXPERIENCE IN THIS TYPE OF RIG: ■. Unknown 1. <3 months 2. 3-6 months 3. 6-12 months 4. >1 year, <3 years 5. >3 years, <5 years 6. >5 years, <10 years 7. >10 years

Weight				Length (feet)						Width Max. (inches)	Height Max. (feet)	Engine HP	Driver Sex	Driver Age	Pro. Experience	Rig Experience	Percentage Night Driving
Total Vehicle	Straight Truck/ Semitrailer	Full/Dolly Trailer #1	Full/Dolly Trailer #2	Overall	Straight Truck/ Semitrailer	Full/Dolly Trailer #1	Full/Dolly Trailer #2	Front Axle to 5th Wheel	Wheelbase								
38 39 40 41	42 43 44 45	46 47 48 49	50	51 52 53 54	55	56	57	58	59 60 61 62	63 64 65	66 67 68	69 70 71	72	73 74 75	76	77	78 79 80

Figure 3 (*continued*). Large truck accident study, size and weight data collection form.

- Time: quarter of year, day of week, time of day
- Location: state, roadway type, direction of travel through site
- Configuration: truck type (combination), tractor/cab, trailer cargo area
- Dimensions: weight, length, width, height, tractor wheelbase, 5th wheel location, oversized
- Truck Characteristics: manufacturer, engine horsepower
- Driver Characteristics: sex, age, professional experience, rig experience, percentage of night driving.

The actual amount of size and weight data collected varied somewhat by the data gathering site. Time, location, and configuration data were obtained for all trucks at all sites. The amount and type of additional data were generally divided as follows:

Location	Definite	Possible or Approximate
Weigh Station	weight	length, width, height, oversized, manufacturer, sex, age
Truck Stop/ Rest Area	length, width, height, wheelbase, 5th wheel, oversized, manufacturer	weight, sex, age, experience, night driving, horsepower
Toll Booth		length, width, height, manufacturer, sex, age

The data collection process mode also varied by the location type. In weigh stations, usually two field investigators worked together. Where the trucks actually stopped on the scale, one FI would record the weight from the scale readouts while the other measured the truck. At those sites where the trucks did not come to a full stop, length data were taken, if possible, from markers set up next to the scale. Driver and other truck data were recorded as they were observed.

At truck stops and rest areas, measurements were made using a measuring wheel. The drivers were informed of the nature of the study to alleviate any suspicions they might have had. Truck weight and personal data were recorded if volunteered by the driver. Conversations with drivers were totally free-form in nature.

Once the completed forms were retrieved from the field, the data were keypunched and put onto a magnetic tape file. Several editing cycles identified and corrected or eliminated improper codes.

SESSION VI

Determining Heavy Truck Exposure from Owner Surveys

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Truck Exposure Estimation Through Fuel Consumption

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Proposed paper to be written for the National Symposium on Commercial Truck Exposure Estimation. The symposium is sponsored by NHTSA and FHWA. The Institute for Safety Analysis has been contracted to organize and conduct the symposium during the second quarter of 1979.

Title: Determining Heavy Truck Exposure from Owner Surveys

Author: K.L. Campbell

Abstract:

The collection of exposure data by HSRI from owners of late model heavy trucks as part of an NHTSA sponsored evaluation of the safety impact of FMYSS 121 is described in this paper. Survey vehicles were randomly selected from manufacturers' sales lists for production years 1974 and 1975. Odometer readings were obtained periodically from owner records during calendar years 1976 and 1977. Descriptive statistics on the vehicles and their use are presented. As part of this project, a second survey of the same vehicles was conducted by telephone in which information on the use of the vehicles on specific randomly selected days was requested. Mileage estimates based on the odometer readings are compared with the information obtained for specific days. Operational problems associated with the use of owner records as a source of information on vehicle use, problems of cooperation, and the resulting response rates are also discussed.

ABSTRACT

TRUCK EXPOSURE ESTIMATION THROUGH FUEL CONSUMPTION

Because the larger commercial vehicles (over 26,000 lbs. GVW) are almost all powered by diesel fuel and relatively few of the remaining vehicles are diesel powered, methods are explored to use diesel fuel consumption as a measure of commercial vehicle exposure. Accident and fatality rates involving commercial vehicles could be compared between states by comparing total diesel fuel consumption, but this would ignore that some states are relatively heavier users of diesel fuel. Supposedly those relatively heavier diesel users are corridor states with large through movements of heavy diesel trucks.

Instead, the ratio of diesel fuel consumed to total highway fuel (DTF) is compared to fatality rates by states. Higher DTF's would indicate relatively greater commercial vehicle exposure as evidenced by higher ratios of truck fatalities to total motor vehicle fatalities. DTF could then be used as a surrogate for exposure to heavy commercial vehicles.

Several factors countering use of DTF's as exposure indices are discussed. Further work is recommended to establish conclusively if the DTF method is satisfactory.

T. May
2/26/79

TRUCK EXPOSURE ESTIMATION THROUGH FUEL CONSUMPTION

by

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National Symposium on Commercial Truck Exposure
Washington, D.C.
April 9-11, 1979

INTRODUCTION

This paper introduces the novel concept of diesel-to-total highway fuel consumption ratio (DTF) as a relative measure of larger commercial trucks' (over 26,000 lbs. GVW) activity. In comparing DTF's by states, states with higher DTF's would then be considered as "corridor" states characterized by relatively heavy out-of-state long haul truck use of highways. That heavy use would then indicate relatively heavy exposure to commercial truck traffic. The ratio of truck fatalities to total motor vehicle fatalities provides a convenient base for correlating DTF to heavy truck accidents. While DTF simplifies measuring relative exposure to heavy trucks, it could be improved by modifying with other factors. These factors are broached but not significantly explored later in the paper.

Underlying the DTF theory is the assumption that gasoline consumption and some diesel fuel consumption largely reflects the overall short haul highway traffic generated within an individual state. The bulk of diesel fuel consumption represents long haul heavy truck traffic. As activity within a state increases, both diesel and total fuel usage would tend to increase, holding DTF relatively constant. If a large amount of heavy truck traffic is generated externally, it would drive up the DTF and the state acquires a corridor character. That state then has its highways used disproportionately more heavily by heavy, long distance trucks.

Figure 1 illustrates one way of presenting the DTF concept. Higher DTF's are observed in an east-west band of states across the contiguous United States where heavy coast-to-coast highway movements would be expected. Colorado stands out as an exception which may be due to major east-west Interstates passing just to the north and south of the state. Peninsular and/or "corner" states would be expected to have low DTF's because long haul traffic deadends there. Strikingly low DTF's in Washington, California, New England, Florida and Michigan tend to confirm the theory.

The ratio of truck fatalities to total motor vehicle fatalities (TTF) is advanced as a preferred measure of the relative likelihood of collision with a truck. Consider the two hypothetical states in Figure 2. In both State A and State B, the same amount of diesel fuel is consumed so the total amount of heavy truck traffic should be the same. However, State B has considerably greater overall highway activity and consequently a lower DTF. At those DTF's, one in ten vehicles traveling in State A would be expected to be a truck while only one in twenty would be in State B. So using diesel fuel consumption as a measure of travel, there would be an equal chance for truck accidents in both states. However, the relative number of truck accidents would be lower in State B where total fuel consumption is higher. Because substantial variances exist in reporting accidents, fatalities were chosen as more exact quantities to substitute for accidents.

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FIGURE 1

CORRIDOR AND NON-CORRIDOR STATES BASED ON D.T.F.

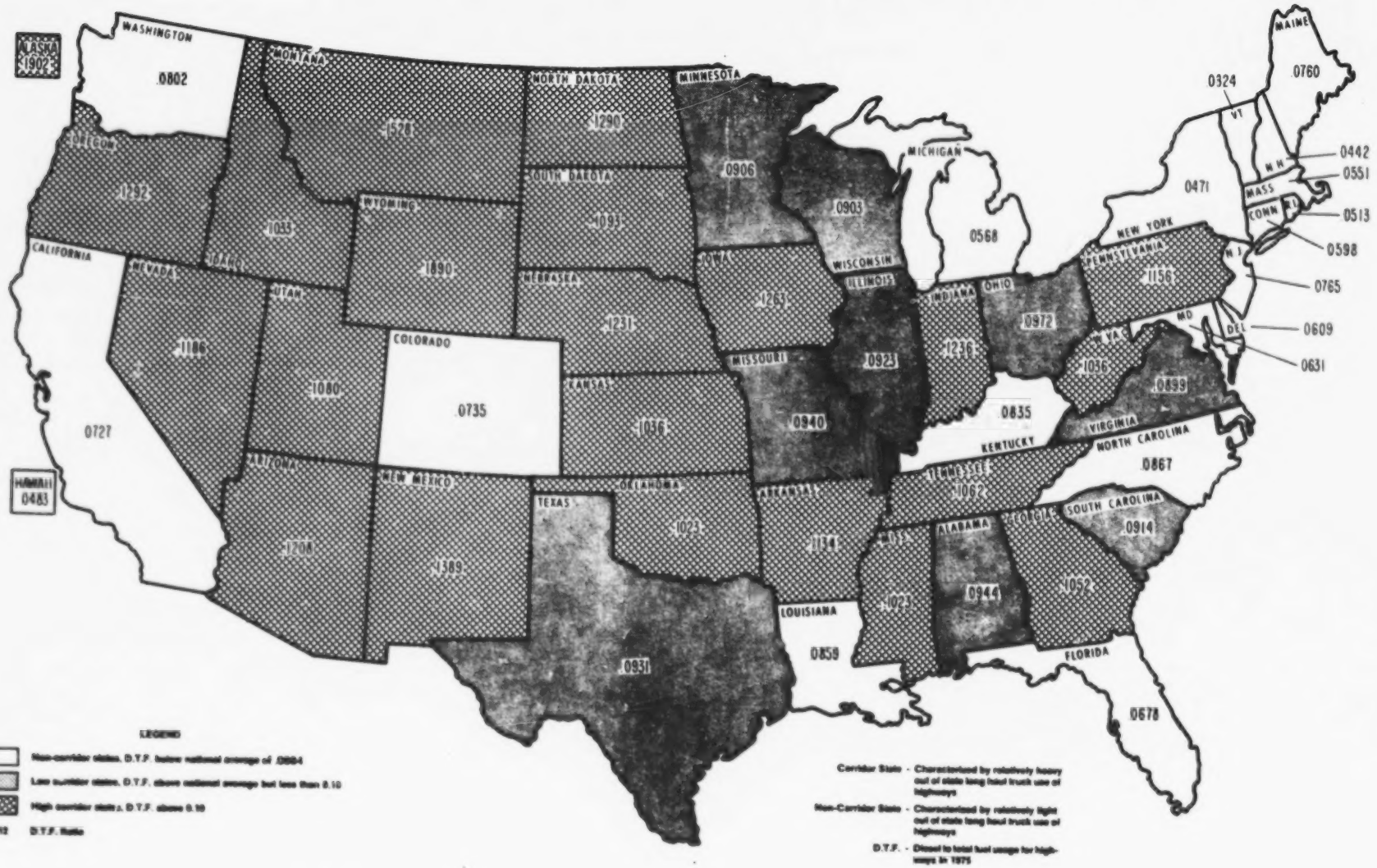

FIGURE 2

Illustration of DTF to TTF Ratio

	State A	State B
Highway System, miles	50,000	100,000
Diesel fuel consumption, gals. x 10^6	100	100
Total highway fuel consumption, gals. x 10^6	500	1,000
DTF ratio	0.20	0.10
No. of heavy trucks in average traffic stream*	1 in 10 vehicles TccccccccTcccccccc d	1 in 20 vehicles Tcccccccccccccccccc d
Expected TTF ratio	0.10	0.05

*Assumes truck fuel economy (MPG) approximately one half that of total traffic.

DTF = Diesel to total highway fuel usage.

TTF = Truck to total motor vehicle deaths.

C = Car

T = Truck

d = Given distance.

Analysis

In Figure 3, diesel and total highway motor fuel consumption are tabulated by state for 1975 and 1977. Truck and total motor vehicle fatalities are similarly tabulated. DTF's and TTF's are calculated and listed in adjacent columns for comparison. States with DTF's above the national average are shaded on the map in Figure 4. Above average TTF's similarly are shaded in Figure 5. In 1975, 38 states match while 35 match in 1977. Consequently, the maps exhibit nearly identical shading patterns.

A linear regression analysis of the unweighted DTF's and TTF's yielded inconclusive coefficients of correlation, r, in the 0.6 range. Weighting the states on a total motor fuel consumption basis increased the r values to 0.87 for 1975 and 0.84 for 1977. Thus, the data confirms a correlation between DTF's and TTF's.

Why not simply use TTF as a measure of the relative likelihood of truck accidents instead of DTF? If some of the influences discussed in the next section can be accounted for, DTF is considered a better overall measure of potential for truck accidents. It remains relatively stable from year to year while TTF can change drastically for a given state------particularly where there are a small number of truck fatalities.

Let's also look at the use of DTF for relative truck exposure instead of simply diesel fuel. As noted in Figure 2, two states could have equal diesel fuel usage, but yet sizeably different DTF's. If a high DTF state wished to optimize its allocation of funds for safety purposes, it would

STATE	1975 Motor Fuel			1975 M/V Fatalities			1977 Motor Fuel			1977 M/V Fatalities		
	Total Fuel (Mgals)	Diesel (Mgals)	DTF	T.T.F.	Truck Fatalities	Total M.V. Fatalities	Total Fuel (Mgals)	Diesel (Mgals)	DTF	T.T.F.	Truck Fatalities	Total M.V. Fatalities
ALABAMA	2056	198	.0448 A A	.0748	57	975	2[illegible]	49	.1094 A A	[illegible]	[illegible]	[illegible]
ALASKA	184	35	.1902 A B	.0434	5	114	217	44	.2274 A A	[illegible]	[illegible]	[illegible]
ARIZONA	1283	155	.1208 A B	.0373	25	670	1457	97	.1297 A B	[illegible]	34	[illegible]
ARKANSAS	1294	20	.1547 A A	.0274	21	564	1438	184	.2424 A A	[illegible]	20	[illegible]
CALIFORNIA	10168	765	.0727 B B	.0465	110	4165	11892	915	.0965 B B	.0287	142	[illegible]
COLORADO	1431	103	.0735 B A	.0308	31	591	1529	125	.0818 B B	.0281	49	720
CONNECTICUT	1404	84	.0598 B B	.0276	21	398	1473	92	.0625 B B	.0267	25	441
DELAWARE	312	19	.0609 B A	.0351	7	127	329	23	.0699 B A	.0301	12	159
FLORIDA	4457	302	.0675 B B	.0382	52	2040	4846	361	.0745 B B	.0420	33	[illegible]
GEORGIA	3042	320	.1052 A A	.0515	22	391	3318	377	.1136 A A	.0760	10	1329
HAWAII	290	14	.0483 B B	.0068		146	321	16	.0498 B B	.0030	0	162
IDAHO	484	50	.1035 A A	.0599		232	549	66	.202 A B	[illegible]	9	344
ILLINOIS	5243	484	.0923 A A	.0614	168	2044	5635	574	.1019 A A	.0745	205	[illegible]
INDIANA	3017	373	.1236 A A	.0855	71	1135	3259	464	.1424 A A	[illegible]	124	[illegible]
IOWA	1671	211	.1263 A A	.0712	48	674	1846	261	.1414 A A	[illegible]	50	681
KANSAS	1371	142	1036 A A	.0561	29	517	1447	150	.1037 A A	[illegible]	24	540
KENTUCKY	1844	154	.0835 B B	.0325	21	882	2031	194	.0955 B A	.0789	10	151
LOUISIANA	1945	167	.0859 B B	.0447	42	940	2226	219	.0984 A B	.0559	02	1110
MAINE	566	45	.0760 B B	.0044	1	226	614	51	.0831 B B	.0270	0	22
MARYLAND	1934	172	.0651 B A	.0409	42	691	2099	127	.0605 B B	[illegible]	35	731
MASSACHUSETTS	2413	133	.0551 B B	.0170	15	884	2528	134	.0530 B B	.0216	22	745
MICHIGAN	4650	264	.0568 B B	.0323	64	1811	5048	338	.0670 B B	.1401	30	1947
MINNESOTA	2054	186	.0906 A B	.0450	35	777	2222	216	.0972 B B	.0546	47	[illegible]
MISSISSIPPI	1280	131	.1023 A B	.0478	24	612	1437	162	.1127 A A	.0678	51	752
MISSOURI	2744	258	.0940 A B	.0474	51	1075	3021	320	.1059 A A	[illegible]	121	[illegible]
MONTANA	478	73	.1528 A A	.1309	55	298	521	89	.1708 A A	.0677	22	325
NEBRASKA	902	111	.1231 A A	.0638	24	376	977	130	.1331 A A	.0919	35	359
NEVADA	447	53	.1186 A B	.0364	9	220	494	56	.1134 A B	.0564	16	294
NEW HAMPSHIRE	407	18	.0442 B B	.0464	7	151	453	21	.0464 B B	.0280	4	143
NEW JERSEY	3476	266	.0765 B B	.0444	48	1080	3549	312	.0879 B A	.0650	72	1108
NEW MEXICO	792	110	.1389 A A	.0581	33	569	884	133	.1505 A A	.0878	60	685
NEW YORK	5128	270	.0471 B B	.0250	86	2458	6121	317	.0518 B B	.0361	79	[illegible]
NORTH CAROLINA	3010	261	.0867 B B	.0381	90	1522	5534	332	.0896 A A	.0784	113	[illegible]
NORTH DAKOTA	372	48	.1290 A A	.0535	7	169	412	58	.1408 A B	.0341	7	205
OHIO	5390	524	.0972 A A	.0619	112	1809	5888	656	.1114 A A	.0767	138	1800
OKLAHOMA	1759	180	.1023 A A	.0642	49	763	1969	230	.1168 A A	.0848	78	806
OREGON	1347	174	.1292 A A	.0557	32	574	1527	209	.1369 A B	.0478	35	690
PENNSYLVANIA	5044	583	.1156 A A	.0572	119	2082	5673	684	.1206 A A	.0885	176	2058
RHODE ISLAND	390	20	.0513 B B	.0268	3	112	402	19	.0473 B B	.0265	1	155
SOUTH CAROLINA	1609	147	.0914 A A	.0536	44	821	1765	172	.0975 A B	.0456	48	1052
SOUTH DAKOTA	421	46	.1095 A A	.0505	10	198	468	54	.1154 A B	.0565	13	230
TENNESSEE	2485	264	.1062 A A	.0603	69	1145	2748	344	.1252 A A	.0695	93	1359
TEXAS	8006	745	.0931 A A	.0490	168	3429	9068	930	.1026 A B	.0464	159	3426
UTAH	685	74	.1080 A A	.0800	22	275	765	98	.1150 A A	.1021	39	382
VERMONT	255	21	.0824 B A	.0486	7	144	289	35	.1211 A B	.0244	3	125
VIRGINIA	2693	242	.0899 A A	.0680	70	1030	2977	290	.0974 A A	.0619	72	1164
WASHINGTON	1821	146	.0802 B B	.0285	22	771	2064	184	.0891 B B	.0254	23	985
WEST VIRGINIA	898	93	.1036 A A	.0720	55	496	974	83	.0852 A A	.0702	37	527
WISCONSIN	2270	205	.0905 A A	.0511	48	940	2490	261	.1048 A A	.0680	65	956
WYOMING	344	65	.1890 A A	.1033	22	213	398	85	.2136 A A	.0969	25	258
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SOURCES: "HIGHWAY STATISTICS", FEDERAL HIGHWAY ADMINISTRATION, 1975 AND 1977.
"ACCIDENT FACTS", NATIONAL SAFETY COUNCIL, 1976 AND 1978.
"ACCIDENTS OF MOTOR CARRIERS OF PROPERTY", FEDERAL HIGHWAY ADM., 1975 & 1977.

NOTE: A ABOVE NATIONAL AVERAGE
B BELOW NATIONAL AVERAGE
* DOES NOT ADD DUE TO ROUNDING, ETC.

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BEST AVAILABLE COPY

FIGURE 4

RATIO OF DIESEL FUEL TO TOTAL HIGHWAY FUEL CONSUMPTION

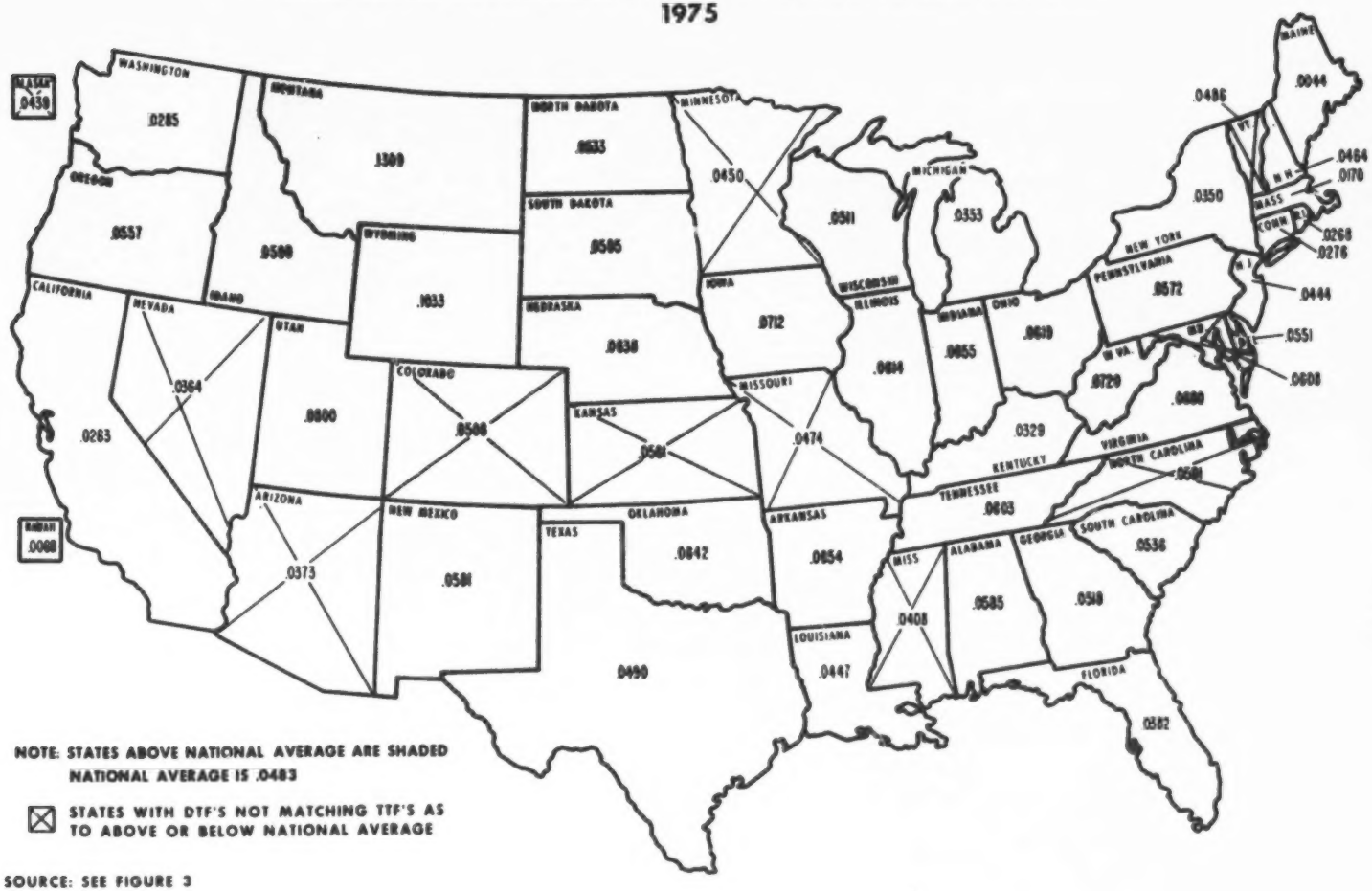
1975

NOTE: STATES ABOVE NATIONAL AVERAGE ARE SHADED
NATIONAL AVERAGE IS .0884

SOURCE: "1975 HIGHWAY STATISTICS", FHWA

FIGURE 5

RATIO OF TRUCK FATALITIES TO TOTAL MOTOR VEHICLE FATALITIES
1975



NOTE: STATES ABOVE NATIONAL AVERAGE ARE SHADED
NATIONAL AVERAGE IS .0483

⊠ STATES WITH DTF'S NOT MATCHING TTF'S AS TO ABOVE OR BELOW NATIONAL AVERAGE

SOURCE: SEE FIGURE 3

distribute relatively more funds to truck related safety than to highway safety in general. For example, suppose a high DTF state could choose between allocating funds to runaway truck lanes or an improved line striping program. If its DTF were high it should opt for the former; low, for the latter. Naturally, such simplification of priorities must be considered in perspective. In the example cited, a flat, high DTF state with little runaway truck experience would seek truck safety programs more appropriate to its condition.

Many factors point to a growing need for emphasis on truck safety. Truck weights, sizes, sales, traffic volumes, and percent of commodities hauled have all been increasing. Some programs, such as truck weight enforcement, are being instituted by the federal government in response to the highway deterioration aspect of heavy (overweight) trucks. Others could follow as trucking grows. Distribution of federal truck related funds for both safety and other purposes could be more equitably distributed if modified by DTF factors. Once again, the more stable DTF figures are preferable to the TTF figures which vary more from year to year.

Influences

Although DTF correlates well to TTF, it may need refinement before it can be gainfully employed. For example, there are a few states with DTF's markedly above average but with TTF's below average.

Many factors could influence the correlation between DTF and TTF. Foremost is the reporting of motor fuel consumption. Gasoline (and increasingly greater but still minor amounts of diesel fuel) for cars can readily be purchased in one state and consumed in another. If one of the states is small, DTF could be affected significantly. Diesel fuel consumption should be fairly accurate in view of many reporting requirements. However, the variation of diesel fuel taxes between adjacent states encourages buying in the lower tax states. The extent of regulation, reporting, enforcement and scruples of individual truckers obviously influences the diesel fuel consumption reporting to some degree.

Highway safety programs may be better in some states than others. While such programs generally affect both truck and total motor vehicles fatalities, some programs may bear heavier on one category than the other, thus affecting the TTF.

Individual states may possess both corridor and non-corridor characteristics in different areas but overall they are placed in one category. For example, because of its extensive coastline, California is a "corner" state with a low DTF characteristic of a non-corridor state. Yet many more inland parts of California would probably exhibit corridor characteristics if DTF could be measured there.

Some states may be too small to meaningfully measure DTF and TTF. Differences in weather and topography may affect either factor. Snow will decrease vehicle efficiency as will air conditioning.

It is assumed that diesel fuel usage parallels long haul truck volumes. The growing number of diesel delivery trucks and diesel automobiles is beginning to affect the assumption in a small way. On the other hand, emission requirements could dampen the swing to diesel power.

Speed enforcement differential may indirectly influence TTF. Despite generally lower fatality rates on higher type facilities, speeds are more likely to increase on those facilities. Since those facilities produce higher long haul truck volumes, truck fatalities and TTF's would increase.

Relative traffic densities, urbanization, truck size and weight, and other factors conceivably could also influence DTF and TTF. Identifying significant influences, evaluating them and determining how or if to employ them, is required to implement DTF/TTF rationally.

CONCLUSION

Correlation is established between DTF and TTF. DTF is viewed as a more stable measure of the relative likelihood of an accident involving a truck. Potentially, it could be employed to allocate highway resources more equitably both nationally and within states. Several factors are identified which influence DTF and/or TTF. Further work is required to evaluate those influences before DTF can be used with confidence.

References

1. "Accident Facts", National Safety Council, Chicago, Illinois, Annual.

2. "Accidents of Motor Carriers of Property", Federal Highway Administration, U.S. Government Printing Office, Washington, D.C., Annual.

3. "Highway Statistics", Federal Highway Administration, U.S. Government Printing Office, Washington, D.C., Annual.

4. "Motor Vehicle Facts and Figures", Motor Vehicle Manufacturers Association, Detroit, Michigan, Annual.

5. "Energy Effects, Efficiencies, and Prospects for Various Modes of Transportation", Transportation Research Board, Washington, D.C., 1977.

SESSION VII

The Annual Truck Weight Study

Perry Kent
Office of Planning
Federal Highway Administration

Iowa Truck Weight Study Training Procedures

Kenneth R. Shuey
Travel Surveys Manager
Office of Transportation Inventory
Iowa Department of Transportation

Developing and Using ADT Data at the State and National Level

Richard Bodle
Federal Highway Administration

THE ANNUAL TRUCK WEIGHT STUDY

The Data Collected and Its Possible Usage in the Measurement of Vehicle Exposure

by

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Abstract

The Annual Truck Weight Study is a cross-sectional survey of traffic taken hourly over one 24-hour period per year to measure the distribution of the various vehicle types in the traffic stream. The Study is conducted at approximately seven hundred locations nationally. In addition, the various types of trucks in the traffic stream are examined in more detail to determine other particular characteristics, such as body type, fuel type, axle weights and spacings, commodities carried, registrations, and class of operation. Since this Study is conducted only one day per year, the data can be used as a tool in the development of a vehicle exposure index only when tempered by other known factors relating to vehicle exposure.

THE ANNUAL TRUCK WEIGHT STUDY

by

Perry M. Kent

U. S. Department of Transportation
Federal Highway Administration
Office of Highway Planning
Washington, D. C. 20591

THE ANNUAL TRUCK WEIGHT STUDY

1. General Background of the Study
   - A. The Early Years - 1936 to 1968
   - B. The Year of Changes - 1969
   - C. The Biennial Weighing Option - 1976

2. The Data Collection Operations
   - A. Classification Counting
   - B. Truck Weighing
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     2. The Information Collected
     3. The Equipment Used
   - C. A Typical Year's Results

3. Data Problems Inherent to the Study
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   - B. Highway System Biases
   - C. The Citizens Band Radio

4. Recent Issues Utilizing the Truck Weight Study Data
   - A. Highway Cost Allocation Study
   - B. Vehicle Size and Weight Legislation
   - C. 10,000# Steering Axle Study
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5. Looking Ahead into the Future
   - A. A Plan for National Data Collection Sites
     1. Classification Counting
     2. Vehicle Weighing
     3. Speed Monitoring
     4. Data Telecommunications
   - B. Weighing-in-Motion Equipment Today

Iowa Truck Weight Study Training Procedures

by

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Abstract

The paper presents a description of Iowa's biennial truck weight program which is conducted at twenty locations throughout the state using both permanent and portable scales. The survey procedure we use has proven to be the safest to the employees as well as the least time and inconvenience to the trucker. Methods of training employees, safety precautions, training aids, survey procedures, average survey costs and utilization of data are the major subjects.

IOWA

TRUCK WEIGHT STUDY

Prepared for: National Symposium on Commercial
Truck Exposure Estimation
Washington, D.C.
April 9-11, 1979

by

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Office of Transportation Inventory
Ph. 515-296-1548

The Iowa Department of Transportation conducts the Truck Weight Study biennially in cooperation with the Federal Highway Administration. This study, which has been conducted since 1936, provides valuable weight distribution data into the design of Iowa's highways.

In addition to knowledge of the volumes of traffic using highway facilities and the proportion of vehicles of each of the several classes, it is also fundamental to know the range and frequencies of loads imposed upon the facilities.

Data on the frequency of application of loads of various magnitudes are a major factor in determining the design of the facilities and in predicting their useful life. Data gathered from weight studies are also useful in estimating ton-mileage of highway transportation, in highway needs studies and highway finance studies, and in evaluating the role of the highway in the total transportation picture.

The objective of vehicle weight and characteristics studies is to provide information on such vehicle characteristics as axle and vehicle weights, loading practices, and dimensions which, in conjunction with vehicle classification and traffic volume information, will provide measures of usage of, and demand upon, the highway systems.

(Exhibit 1 - Weight Information Collected
During Truck Weight Operations)

(Exhibit 2 - Count Information Collected
During Truck Weight Operations)

In 1936, 1,345 trucks were weighed at 10 rural locations, compared to 1977 when, at 19 of our present 20 locations, 23,805 trucks were weighed.

(Exhibit 3 - Amount of Trucks Weighed and
Counted, 1936-1977)

It is impracticable to weigh all vehicles to determine weight frequencies and the tonnage of commodities moved on the highway system. It is possible for us to obtain the desired data by statistical sampling techniques from which estimates can be made that are accurate within reasonable limits of tolerance.

Field operations are conducted at twenty (20) locations: seven on Interstate Highways, nine on Primary Highways, and two each on Secondary Roads and Local Urban Streets.

(Exhibit 4 - 1936 Truck Weight Locations)

(Exhibit 5 - 1977 Truck Weight Locations)

The schedule is prepared so that each station is operated during comparable periods for the preceding studies. Manual counts are made every year, while the weighing operations are conducted during the odd numbered years only. Vehicle classification counts are made for twenty-four

hours. Weighing operations are conducted for fourteen hours in two shifts: 6 a.m. to 1 p.m. and 2 a.m. to 9 p.m. at all locations. A third weighing shift, 10 p.m. to 5 a.m., is conducted at the seven interstate locations and one primary location. In order to obtain unbiased data, we do not use law enforcement officials.

A combination of portable truck weight scales and existing pit scale locations are used to collect the truck weight data. The 1974 National Truck Characteristics Report developed by the Federal Highway Administration shows that Iowa spends $2.09 per truck weighed compared to $7.79 per truck as a U.S. average. When comparing total dollars spent for truck weight in Iowa to the national average, we find we spent 2.8 percent of the total; whereas, we weighed 10.6 percent of the trucks reported to FHWA for the year of 1974.

(Exhibit 6 - Table Showing Truck Trends in Region 7 by FHWA)

It must be recognized that when survey personnel operate on the traveled portion of the road, there is a great deal of hazard involved. Every safety precaution possible, on our part, is taken not only to protect our employees but to protect the motoring public. Each individual is required to wear a safety vest and hard hat.

Fourteen temporary summer employees made up of high school graduates or college students are used to conduct the study. Their duties vary and each individual is trained to perform all positions. The group is divided into two seven-person crews with a full-time person as the overall supervisor.

A manual, entitled, "Truck Weight Survey - Instructions and Schedules," is used to instruct the crews on how to weigh. This training is supplemented with a 30-minute video tape illustrating weighing operations and 35mm slides to identify truck body types. The total orientation and training program normally lasts approximately eight hours.

The weighing schedule includes four (4) different types of station locations at which trucks are stopped, weighed, measured, and the driver interviewed.

Each of these stations are carefully laid out to control and direct traffic into and through the weighing area.

If excessive traffic accumulates, weighing operations are temporarily discontinued until congestion is removed and weighing operations can be safely resumed.

The usage of much of the information obtained under these procedures is not limited to formal reports or annual summaries. It is useful as basic data in pavement design, determination of truck usage and volume trends, evaluation of service performed by a highway or a system of highways, location of heavy-duty truck routes, cost allocation, and economic justification studies.

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WEIGHT INFORMATION COLLECTED DURING TRUCK WEIGHT OPERATIONS

Commodity	Code
Ammonia	28190
Asphalt Shingles	29520
Green Beans	01390
Beer	20821
Bottles (Empty)	32210
Burial Vaults	34500
Cars	37111
Caterpillar	35310
Cattle	01411
Cement (Dry)	32411
CO_2 (Carbon Dioxide)	28130
Concrete (wet Mix)	32710
Eggs	01520
Feed (Bulk)	20421
Freight (General)	41100
Furniture	25000
Gravel	14412
Hay	01191
Hogs	01413
Horses	01920
Household Goods	41100
Insulation	32900
LTL	41100
Lumber	24000
Meat (Boxed)	20120
Meat (Swing)	20110
Milk Process	20260
Motorcycles	37500
Oats	01133
Pallets Wood	42100
Parcel	47100
Plywood	24300
Pop	20860
Potatoes	01195
Potato Chips	20900
Poultry	01510
PreFabHomes	24320
PreFab Steel Bldg	34410
RR Tools	34200
Refrigerator	36320
Roofing	29520
Soybean	01144
SoybeanMeal	20923
Steel (Axles & Beams)	33125
Steel (Pipes & Tubing)	33126
Steel (Rods & Bars)	33124
Steel Sheets	33123
Tools	34200
Tractors	35200

	TYPE	STATE	HWY. SYS.	STA. NO.	DOT	YEAR	MO/L	DATE	HOUR
7 - 8									
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17									

Form 150-d
7.1., 2-79

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF TRANSPORTATION INVENTORY
AMES, IOWA 50010
TRUCK WEIGHT SURVEY RECORDER FORM

SHEET ___ OF ___
RECORDER _____

WEIGHTS BY _____
CODED BY _____

CONTROL NO.	VEH TYPE: GEN (18)	VEH TYPE: TYP AX (19)	VEH TYPE: REG AX (20)	VEH TYPE: TRL AX (21)	VEH TYPE: STATE (22)	VEH TYPE: AXLE (23)	BODY TYPE (24)	FUEL TYPE (25)	GROSS REG WGT GROUP (27)	REG WEIGHT (28 30 31)	BASIS REG (32)	MODEL YEAR (33 34)	CLASS OP (35)	COMMODITY (36 37 38 39 40)	E OR L (41)	TOTAL WEIGHT (42 43 44 45)	AXLE WEIGHTS: AXLE A (46 47 48)	AXLE WEIGHTS: AXLE B (49 50 51)	AXLE WEIGHTS: AXLE C (52 53 54)	AXLE WEIGHTS: AXLE D (55 56 57)	AXLE WEIGHTS: AXLE E (58 59 60)	AXLE MEASUREMENTS: AXLE A-B (61 62 63)	AXLE MEASUREMENTS: AXLE B-C (64 65 66)	AXLE MEASUREMENTS: AXLE C-D (67 68 69)	AXLE MEASUREMENTS: AXLE D-E (70 71 72)	TOTAL WHEEL BASE (73 74 75 76)	SERIAL NO. (77 78 79)	CARD NO (80)
1																												
2																												
3																												
4																												
5																												
6																												
7																												
8																												
9																												
10																												

EXHIBIT 1

T.I., 2-79

OFFICE OF TRANSPORTATION INVENTORY
AMES, IOWA 50010
TRUCK WEIGHT SURVEY COUNT FORM

TYPE	STATE	HWY. SYS.	STA. NO.	DOT	YEAR	MON.	DATE	HOUR
7	1 - 9							
1 2	3	4 5 6	7 8	9	10 11	12 13	14 15	16 17

COUNTER _____
CODER _____

COUNT INFORMATION COLLECTED DURING TRUCK WEIGHT OPERATIONS

Circle Direction of Travel			North 1 East 3		South 5 West 7		North 1 East 3	South 5 West 7	North 1 East 3	South 5 West 7
PASSENGER CARS	Standard and Compact	18					Type 327000	Type 327000	Type 521100	Type 521100
		19								
		20								
		21					Type 323000	Type 323000	Type 521200	Type 521200
		22								
	Small	23								
		24								
		25					Type 331000	Type 331000	Type 531100	Type 531100
		26								
		27								
Motorcycles and Motor Scooter		38								
		39					Type 337000	Type 337000	Type 531200	Type 531200
		40								
Commercial Buses		41								
		42								
		43								
		44					Type 333000	Type 333000	Type 533400	Type 533400
School Buses		45								
		46								
		47								
SINGLE UNIT TRUCK	200000 Pickup and Panel	48					Type 334000	Type 334000	Type 621100	Type 621100
		49								
		50								
		51								
	210000 Heavy 4 Tire	52		P.U.		P.U.	Type 343000	Type 343000	Type 622100	Type 622100
		53								
		54								
		55								
	220000 6-Tired Dual Rear Tires	56		P.U.		P.U.	Type 421000	Type 421000	Type 622200	Type 622200
		57					P.U.	P.U.		
		58								
		59								
	230000 3 Axle	60					Type 422000	Type 422000	Type 623200	Type 623200
		61					P.U.	P.U.		
		62								
SEMITRAILER COMBINATION	321000 2 Axle Tractor 1 Axle Trailer	63					Type 423000	Type 423000	Type 211079	Type 211079
		64					P.U.	P.U.		
		65								
	322000 2 Axle Tractor 2 Axle Trailer	66					Type 424000	Type 424000	Type 221079	Type 221079
		67					P.U.	P.U.		
		68								
		69								
	332000 3 Axle Tractor 2 Axle Trailer	70					Type 431000	Type 431000	Type 231079	Type 231079
		71								
		72								
		73								
			Type 220800		Type 220800		Type 432000	Type 432000		
			Type 230800		Type 230800		Type 433000	Type 433000		
			Type 240800		Type 240800		Type 434000	Type 434000		

EXHIBIT 2

NUMBER OF TRUCKS WEIGHED AND COUNTED
1936-1977

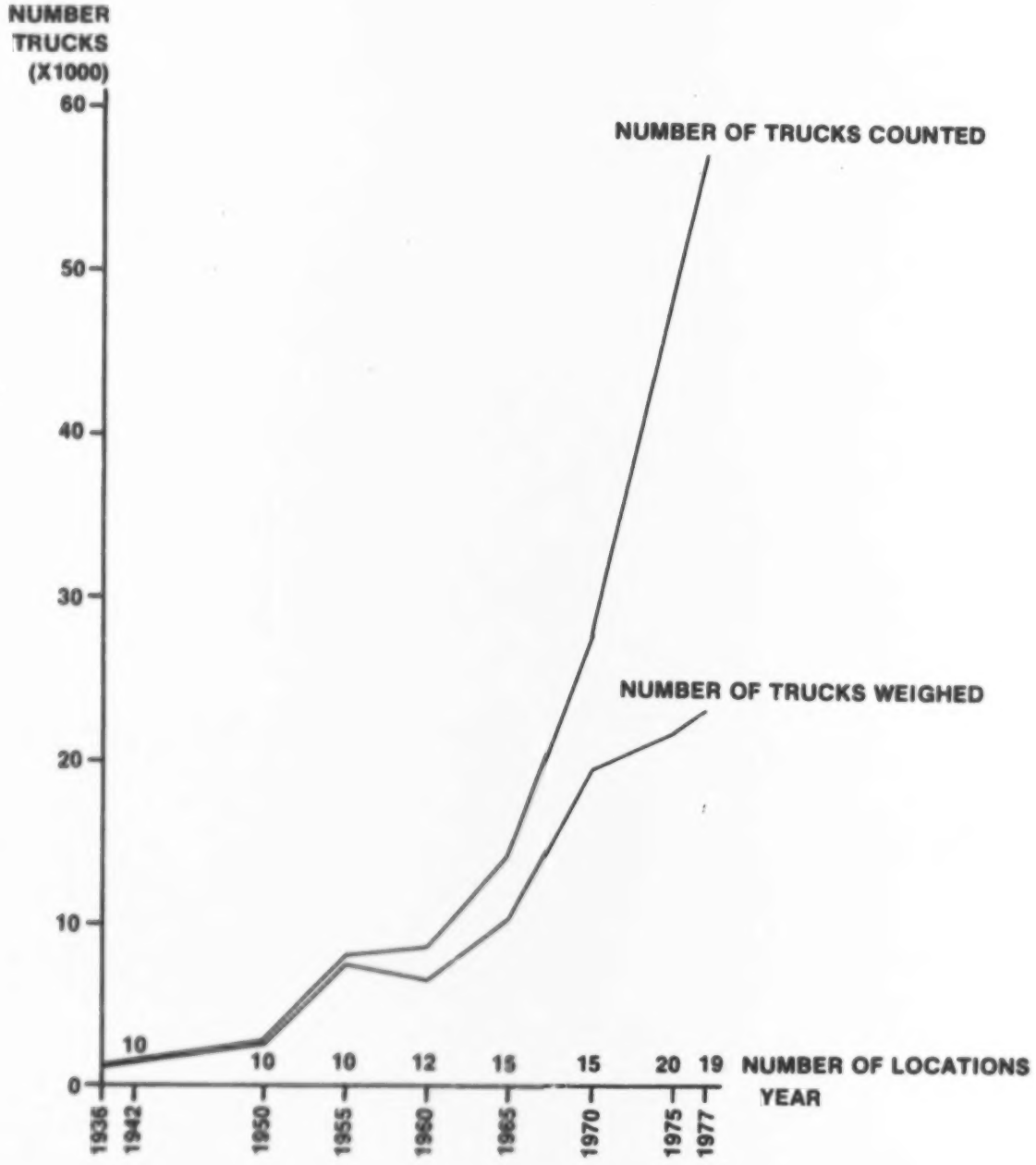
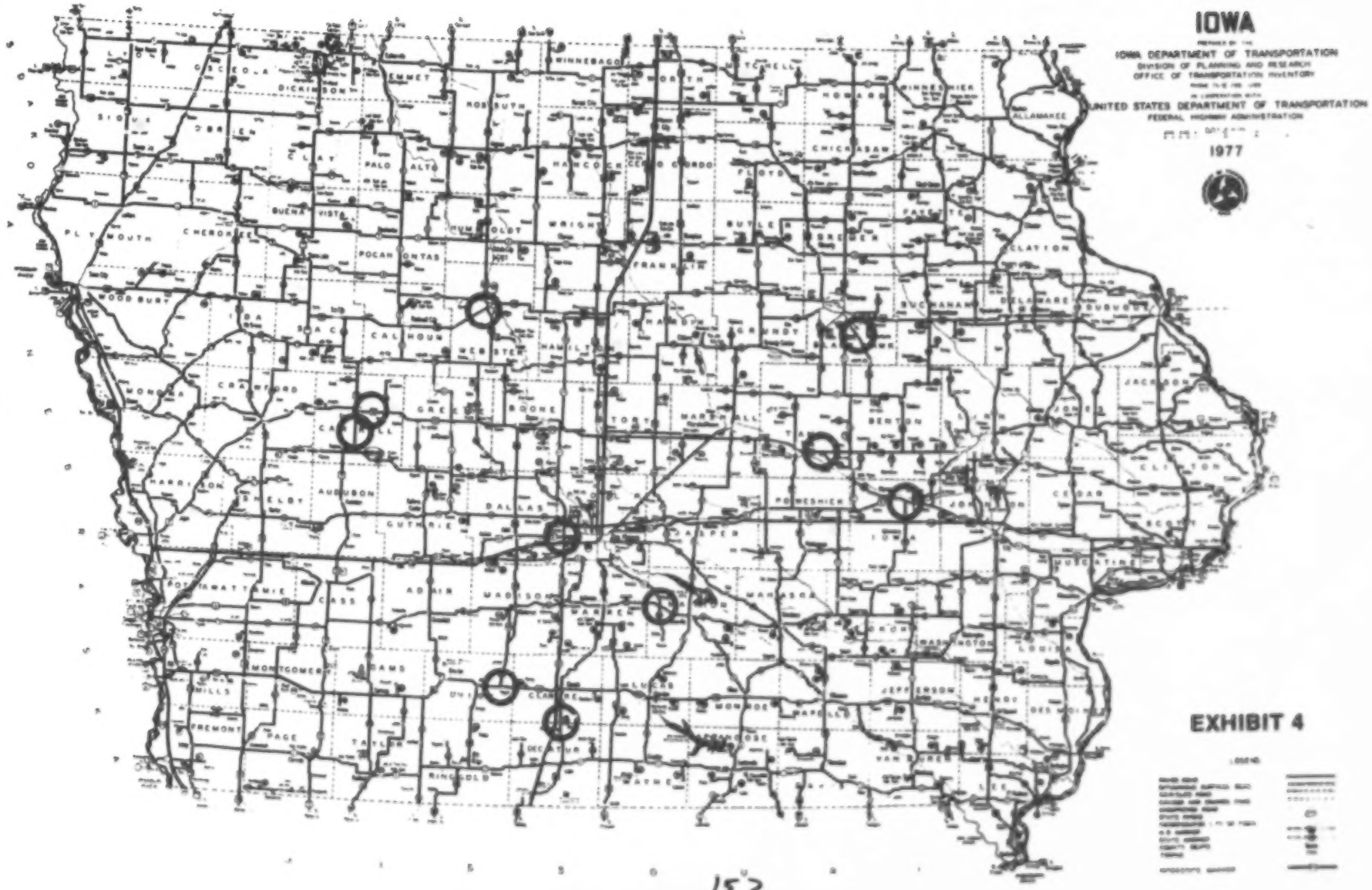


EXHIBIT 3

1936 TRUCK WEIGHT LOCATIONS



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1977 TRUCK WEIGHT LOCATIONS

TABLE SHOWING TRUCK TRENDS
IN REGION 7 BY FHWA

1974 ANNUAL TRUCK WEIGHT STUDY

SIGNIFICANT DATA

STATE	NO. OF STATIONS	TRUCKS		TRUCKS WEIGHED AS A PERCENT OF TRUCKS COUNTED	HP & R FUNDS PROGRAMMED	PLANNING PROGRAM DOLLARS PER TRUCK WEIGHED
		COUNTED	WEIGHED			
IOWA	16	44,732	23,964	53.6	50,000	2.09
KANSAS	15	28,579	2,961	10.4	25,100	8.48
MISSOURI	12	40,422	2,496	6.2	10,000	4.01
NEBRASKA	14	26,137	3,051	11.7	13.500	4.42
U.S. TOTALS	684	2,157,730	225,443	10.4	1,755,750	7.79

EXHIBIT 6

DEVELOPING AND USING AADT DATA AT THE STATE AND NATIONAL LEVEL

By

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Office of Highway Planning

Federal Highway Administration

Developing and Using AADT Data at the State and National Level

General

During the past decade the requirements placed on highway and transportation agencies have expanded greatly. To an agency concerned with the planning, design, construction, operation and administration of transportation facilities, the provision of information on system usage is increasingly important. Traffic data serves as one basis for evaluating service provided by today's highway systems as well as being a necessary ingredient for forecasting future demands. Traffic characteristics data are fundamental measurements and are necessary for all phases of highway development and operation. The need for more reliable and detailed traffic data has expanded to support analysis of related concerns such as land use, air and water quality, noise abatement, energy conservation, modal split, safety, etc. A safety-related use of traffic data is the subject of this Symposium--commercial truck exposure.

The parameters for measuring highway system usage are the amount and characteristics of the traffic volumes on the highways. These measures may indicate usage on statewide systems, portions of systems or on individual highway sections. Typical traffic measures are annual average daily traffic (AADT), average daily traffic for some period less than a year (ADT), directional and lane distributions, temporal variations (month, day of week, hour), peak hours, composition (vehicle type), and vehicle-miles of travel (VMT). State highway and transportation departments

conduct traffic volume studies annually in order to gather traffic data for planning, programming, design, and operational uses. These studies must also be the source of traffic data for determining truck exposure.

Methods of Measuring Traffic Characteristics

Engineers and planners gather traffic data in several different ways. Continuous recorders (ATR's) are operated at locations where detailed hourly volumes are desired for everyday of the year. ATR's are supplemented by seasonal or control stations which are operated periodically throughout the year for varying periods of time. A typical operation calls for collecting 7 days' data each month. A primary use of ATR and seasonal data is in calculating adjustment factors for expanding short counts to estimates of AADT. Data on composition of the traffic stream (vehicle types) is gathered largely through manual classification counts. Detailed vehicle type counts are made each year at locations where trucks are weighed for planning purposes.1/ Other less detailed classification counts are made at ATR's and other locations. The greatest portion of a State's traffic data is obtained from short period counts (up to 48-hours duration) taken once or twice per year at a given location. From various combinations of these types of field data must come the many pieces of traffic information and estimates required by decisionmakers in managing our vast highway programs.

Estimating AADT-By Section

Estimates of AADT by section may be the most used single item of traffic data. Since once-per-year coverage counts form the basis for much of the published traffic data, States must have some method for adjusting

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1/"Guide for Truck Weight Study Manual," Federal Highway Administration, April 1971.

or factoring short counts to annual average estimates. These adjustment factors are produced using data from ATR's and seasonal control stations and relate particular weeks or months to annual average traffic. Several methods are employed by States in determining which ATR's or control stations to associate with short coverage counts. These may be described as follows:

1 - Single station association,

2 - Geographical grouping, and

3 - Grouping based on similar seasonal volume patterns.

For many years many States simply associated rural coverage count locations with one or more ATR's and control stations having "similar" travel patterns. This association was generally done by a traffic engineer or technician based on his personal familiarity with the State. Once the association is identified, factors can be calculated to adjust 24-hour counts to AADT estimates (i.e., AADT ÷ Average Weekday of the Month). The obvious disadvantage of this procedure is its complete dependence on individuals' judgment and opinions. One approach toward a reproducible procedure is to group ATR's and control stations by geographic area (and perhaps road type). Factors computed at each ATR or control station in a group are averaged to produce a set of average group monthly factors to be applied to short counts in that geographic area.

Yet another method of grouping ATR's and control stations is based on similarities of seasonal (monthly) traffic variation. The object here

is to identify counting stations where the relationships between AADT and average monthly weekday traffic are sufficiently similar that average group adjustment factors will produce satisfactory estimates of AADT when applied to 24- or 48-hour coverage counts.

AADT estimates by section are generally prepared by States annually or biannually and reported in route logs or traffic flow maps. Traffic flow maps generally show annual 2-way traffic for all vehicles. Sometimes the percent of trucks is annotated. This type of pictoral presentation is general in nature and not very useful for detailed analyses. Route logs generally contain more detailed information for more easily identifiable route sections. In addition to AADT for each section, often such additional data as section length, directional distribution, percent trucks, and design hour volume are available. Some of these data will be useful in determining truck exposure rates. The potential exists, from a traffic standpoint, for calculating these rates by section or route with a geographical breakdown, although using these records may not be the most efficient way to attack the problem.

VMT Estimation

Perhaps an equally useful traffic measure would be vehicle-miles of travel (VMT) estimated for some desirable highway system and/or geographic breakdown. Based on the type of traffic counting activity described above, most States are able to calculate VMT for their major functional systems. Estimates are also made for collector and local roads and

streets but are somewhat less reliable due to their dependance on fuel consumption rate data. Traditionally, total statewide VMT has been determined from fuel consumption data. VMT for locals and collectors was then estimated by subtracting VMT on major systems which was based on traffic data. Increasing emphasis is being placed on obtaining VMT estimates based on traffic data for the lower order systems. Consequently, some States are doing more counting on these roads. It is not uncommon for county roads to be counted on a 3-, 5-, or 7-year cycle. Unfortunately, most of the counting is of total vehicles without attention to vehicle types. A few States update these estimates annually or biannually when preparing county and State traffic flow maps. It is not likely that additional counting and classification on low order roads can be afforded by State highway and transportation departments.

FHWA Traffic Data

A limited amount of highway traffic data is forwarded to FHWA by the States. From ATR's FHWA receives monthly reports of hourly traffic data. These data are used to produce the monthly "Traffic Volume Trends" and for special purpose analyses. Among other highway related statistics reported to FHWA, States report vehicle-miles of travel by highway group. These data are published for each State in Table VM-2. These figures are for

total vehicle travel by system within a State without any breakdown by vehicle type. Using vehicle type data from the annual truck weight studies and the VM-2 data, FHWA compiles a national travel summary table (VM-1) which presents VMT by highway group and vehicle type. Non-passenger vehicles are broken down into single unit trucks, combinations, and total trucks.

A Potential New Data Source

Periodic reports to Congress have often required the FHWA to collect traffic data on a sample of road sections in each State. In recent years, there has been a growing recognition of the need for a mechanism that permits monitoring the performance of our highway system. The FHWA is now developing a Highway Performance Monitoring System (HPMS) which will provide this capability for the various functional systems (less attention will be given to locals). Data will be collected and kept current on a permanent panel of sample road sections. The details of this system need not be discussed here. However, particular attention is warranted to the traffic data to be collected. For each sample section, data on AADT and percent trucks (peak and off-peak) will be collected. The potential exists, then, to obtain statewide estimates by system, of truck VMT. Of course, nationwide estimates by system would also be possible.

Initial data collection will occur during the latter part of 1979 to provide input for the 1980 Report to Congress. Traffic data collection on this panel of sample road sections will be limited to total trucks. Plans now in the formative stage call for future case studies on vehicle type distribution. The intention is to develop typical vehicle

distributions for application to statewide estimates. Conceivably this would enable VMT estimates by vehicle type.

It is our hope that all States will contribute to HPMS. In this case, the input data would be assembled and be available in each State. Analysis procedures, including factoring to statewide estimates, are now being developed here in FHWA Headquarters (HHP-12).

Summary

Normal State traffic data records provide a fine source of data for your purposes. The AADT and percent truck estimates should be available for each major highway segment. Data are usually stored on computer tape or discs. Certainly until HPMS is well established, State records will continue to be the primary source of traffic data for truck exposure analysis. Traffic data from ATR's maintained by FHWA is much too meager to be of value for your purposes.

SESSION VIII

Methods for Estimating Exposure of Trucks and Operations

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Measuring the Visual Impact of Trucks in Traffic

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Methods for Estimating Exposure of Trucks and Truck Operators

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This paper will address a number of approaches to measuring commercial truck exposure, namely, driver logs, company records, the International Registration Plan, induced exposure, driver estimates, State Utilities Commission records, O and D surveys, and vehicle inspection receipts. Examination will be made of driver, vehicle, carrier, and environmental characteristics that each approach provides and discuss the advantages and limitations of each method. Discussion will also include potential modifications that would enable greater use of the information. For example, at the present time some states compile information from vehicles on the International Registration Plan, including estimates of mileage accumulated in each state. While information is collected on vehicles with at least three axles and a GVW of 26,000 pounds or more, there is no further breakdown of vehicle characteristics. However, the addition of vehicle license plate number on the report form would enable linkage with the vehicle registration file which would immediately make available extensive information on vehicle characteristics. The paper will explore such possibilities and discuss how various approaches might be coordinated to arrive at a more comprehensive picture of commercial driver and vehicle exposure.

Methods for Estimating Exposure of Trucks and Truck Operators
Preliminary Outline

I. Introduction - Concept of Exposure

- A. Vehicle Miles Traveled (VMT)
- B. Driver Miles
- C. Quality of Exposure
  1. Highway Type
  2. Roadway Characteristics (including mile posts)
  3. Day of Week
  4. Time of Day
  5. Traffic Density
  6. Weather Conditions

II. Purpose of Exposure Estimates

- A. Driver Regulation
- B. Vehicle Modification
- C. Roadway Evaluation

III. Methods for Estimating Exposure

- A. Driver Logs
- B. Company Records
- C. IRP
- D. Induced Exposure
- E. Driver Estimates
- F. O & D Surveys
- G. State Regulatory Authorities
- H. Insurance Records
- I. Vehicle Inspection Programs

IV. Proposed Modifications to Existing Data Collections

- A. IRP - Vehicle plate # (would enable linkage to registration file, thus providing extensive vehicle information).

IV. Proposed Modifications to Existing Data Collections (Con't)

B. Induced Exposure - Based on existing accident reports. VIN's especially troublesome in case of trucks. By verifying VIN immediately through license plate check, extensive vehicle data could be considered in measures of induced exposure.

C. State Regulatory Authorities

D. Vehicle Inspection Receipts - add odometer reading to inspection sticker and each year record previous year's reading with date and current reading with date. Provides vehicle mileage, thus estimates of fleet mileage.

E. O & D Surveys - Driver age experience with vehicle type (slip seat driver or assigned to a particular vehicle?), length of time driving on this trip, type of operation (common carrier, contract carrier, private carrier, or independent trucker); license plate number to link to registration file for vehicle data.

F. Insurance Records - Fleet mileage by truck type within carrier, fleet mileage by driver characteristics, fleet mileage for carriers covered.

V. Proposed Comprehensive Data Collection Plan

				Environmental Characteristics				
	Driver Exposure	Vehicle Exposure	Carrier Exposure	Highway Type	Day of Week	Time of Day	Traffic Density	Weather Conditions
Logs	X	X	X		X	X		
Company Records	X	X	X					
IRP - Trucks ≥2600		Limited	? Probably					
Induced Exposure from Accident Records	X	X		X	X	X		X
Driver Estimates	X	X						
State Regulatory Authorities			Limited (only common & contract)					
Vehicle Inspection		X	Potential					
O & D Surveys	X	X			X	X	X	
Insurance Records	X	X	X					

MEASURING THE VISUAL IMPACT OF TRUCKS IN TRAFFIC

by

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Abstract

Techniques were developed and applied to measure the visual impact of a motor truck combination under varying types of traffic, and on different highway systems. Adopting the assumption that any person who could be seen from a moving vehicle could, in turn, see that vehicle, measurements were made of the number of motor vehicle occupants, pedestrians and others who observed the passage of a truck combination on various highways in four typical areas of the Nation. Only actual truck routes were utilized and rush hour periods were avoided. A portion of the field research involved measurements of the amount of time a motorist will spend behind a truck prior to attempting a passing maneuver. As a spin-off of the research, average operating speeds on ten types of highways were obtained and compared with other published material. Final analyses permitted estimates of total visual impacts, by road type, on per hour, per mile and per year bases.

MEASURING THE VISUAL IMPACT OF TRUCKS IN TRAFFIC

by

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Symposium on Commercial Truck
Exposure Estimates

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Washington, D.C.

Genesis

A number of years ago, the organized trucking industry embarked on a truck sign campaign to inform the public as to the amount of highway taxes paid by typical trucks operating over the roads of the Nation. Soon this program generated the question of just how many persons actually saw the signs placed on the rear sections of trucks and combinations.

Answering this seemingly simple question, which translated into advertising terms became "what are the number of visual impressions of a truck in traffic", led to a report entitled "How Many People See a Truck?" Utilizing visual observation and the time over distance techniques first developed in sports car rallyes, the 1960's study was relatively crude, quick and basic -- but it was also a first attempt to quantify the phenomenon.

By 1977, it had become obvious that the original work, based as it was on a limited number of observations in and around Washington, D. C., was outdated and inadequate. Further, it had been utilized for purposes far beyond those which the data would support. Obviously, a new and more comprehensive analysis was needed.

Purpose

The present research was undertaken with a grant from the 3M Company as an attempt to determine how many persons actually see trucks -- particularly combination vehicles -- in traffic in the course of a year, a mile, or an hour. Also to be determined was the portion of such vehicles actually viewed -- the front, the sides and/or the rear. With regard to the last, information was desired as to just how long the average motorist follows a truck before attempting a passing maneuver.

To make the findings both more valid and more utile, it was also deemed desirable to obtain information for various types of highways, under varying traffic conditions and in several typical areas of the country. Only actual truck routes would be utilized in the course of the work in order to further validate the findings. In all things, the guiding principle was to be typicality as to place, time and operations.

The purposes of bringing this report and the methodologies employed to produce it to the attention of this Symposium are two-fold. First and most obvious, is to bring a current state-of-the-art analysis to the attention of others working in the field of truck exposure. At the same time, the techniques which have been developed and employed may be adapted or adopted by others to produce a quite considerable volume of utile data at a relatively low cost both in terms of time and money.

It is recognized that what has been done in "The Visual Impact of Trucks in Traffic" represents only one approach to measuring truck exposure. There are obviously many others, each filling a separate need. However, this is a field in which there is as yet little literature or precedent. Thus, a start must be made at some finite point.

Approach and Methodology

To achieve the desired data goals, it was decided to conduct field research in four typical areas of the Nation. Chosen were the Philadelphia Pennsylvania/Camden New Jersey area as being typical of Eastern traffic patterns -- neither best nor worst. Pennsylvania has the third highest truck registration in the Nation. The Houston Texas area is typical of the open Southern/Southwestern environment with Texas being the situs of the second largest number of registered trucks in the U.S.

Chicago has long been considered the hub of American transportation, while California has the largest number of trucks registered of any state. In California, field research was carried out throughout the San Francisco Bay area. To further refine the data base, observations were conducted over ten different types of highways and streets -- rural, suburban and urban. In conformity with long-held principles of traffic analysis, work was confined to non-rush-hours of mid-week days during non-holiday weeks in the summer. This is believed to yield data most nearly typical of year-round averages.

To still further validate the work, all observations were carried out on actual major truck routes and these were determined after consultation with local motor carriers in the areas chosen for study. Some night observations were made, and it was found that visual impacts are minimal during the hours of darkness due primarily to the lack of other traffic and also to the fact that the great bulk of night truck operations occur in rural areas. Traffic, weather and road conditions were noted in all instances.

Insofar as was feasible, three separate sets of observations were carried out in each of the individual field surveys -- namely counts of the number of pedestrians which viewed a truck in traffic, the number of other vehicles which were exposed to a truck, and finally the time required by other vehicles to pass a truck. Thus, a given highway route or section was usually traversed three times since it was not possible to perform more than one type of observation per run.

The basic approach utilized was to operate a station wagon or van in traffic at a speed -- and in a manner -- which would simulate the operation of a large combination truck. Observers in this vehicle would then count persons or vehicles which they could view as they moved through traffic, on the assumption that if a person or vehicle could be seen by the crew of a test vehicle, the reverse would also be true and the test vehicle --

or truck surrogate -- could be viewed by others. In fact, since a combination truck is larger -- and especially higher -- than is a passenger vehicle, it is believed that the data obtained represent an approximately 10 percent understatement and are thus conservative.

The observations utilized for determining following or passing time were carried out in a similar manner, and these, too, are believed to be conservative since most motorists are more willing to pass another passenger vehicle -- regardless of the speed differential -- than they are a large truck.

As to the mechanics involved, the test vehicles were operated by a professional truck driver and carried a crew chief and three observers. Odometers were calibrated, and on-board equipment included stop watches and hand counters. Each observer utilized a one-time worksheet for each observation run, and the crew chief entered locational and descriptive information on pre-prepared master worksheets. Each run was coded for identification.

Odometer readings were noted at the beginning and end of each test section -- most of which were at least five miles long -- and the stop watches provided elapsed times. For analysis purposes, time of day was also noted. Utilizing the elapsed times and mileages, average speeds and average impressions per mile and per hour could be calculated -- thus permitting uniformity of information regardless of location, route length or speed.

Based on pre-operational training sessions, each observer was assigned one or more "sectors" for counting purposes, each corresponding to the front, left side, right side or rear of the vehicle. This required one observer be placed facing backward, and that assignment was rotated to reduce tedium. Observers were instructed to count only persons or vehicles within their sectors commencing and terminating at the command of the crew chief who operated the stop watches and controlled the route. Persons or vehicles facing away from the test vehicle were not counted.

Other vehicles viewing the test vehicle were converted into person observations during the analysis process utilizing Federal Highway Administration conversion factors of 1.5 persons per urban vehicle, 1.8 persons per suburban vehicle and 2.3 persons per rural vehicle. Buses were separately noted and were converted to person impressions at a uniform 15 persons each as an average.

The procedures utilized for determining following times were somewhat different since each observation was an individual timed occurance. During test runs for such purposes, only two observers were needed with one operating a stop watch and the other noting the results. For uniformity, following times were

averaged -- with ranges -- for each such test run. This permitted classifications by road and traffic type and location.

Adequate pre-field preparation permitted all observations to be carried out over a four-week period during the summer of 1977, with one week each being spent in the four areas chosen. In all, 161 test runs were made covering 1,633 test miles. Actual road observations took just over 47 and one-half hours. Stem mileages and on-site route testing required an additional 700 miles and approximately 20 hours.

A breakdown of the test operations showed that 62 pedestrian count runs and 51 vehicle count runs were performed. Vehicle following time runs totaled 48 and these produced 423 observations. Research was carried out over ten different types of roads and streets with cumulative mileages on each ranging from a low of 78 miles on toll bridges and approaches to a high of 379 miles on suburban multilane facilities. Other highway types consisted of rural, suburban and urban Interstates, rural toll roads, rural multilane and 2-lane primaries, urban arterials and city streets.

Results

The analysis found that the average vehicle combination, traveling just under 50,000 miles per year, creates almost 5 million visual impressions in a twelve month period. Of this total, 81 percent of the viewers see the front and one or both sides, 11 percent see only the sides and 7 percent see the rear. Overall, 94 percent of all visual impressions originate with drivers and occupants of other motor vehicles while only 6 percent originate from roadside pedestrians.

Tables were prepared which permit the estimation of visual impressions per mile, hour and year for each road system at various average operating speeds. These were found to vary significantly by road type with the heaviest concentrations per mile being registered for the urban road systems. On a per hour basis, high concentrations were found in both urban and suburban environments. As might be expected, the lowest rates of visual impressions were tabulated for the older rural 2-lane highways.

Night observations, limited to rural areas, confirmed a hypothesis that visual impressions are basically a function of total vehicle travel on a highway facility. Thus, for example, if nighttime average hourly total volume on a given truck route is 40 percent of the daytime average, nighttime visual impressions will be no more than 40 percent of the daytime level.

The following time data required several different types of analyses. While, overall, a vehicle will pull out and pass a truck more quickly as the average speed increases, the data were far from uniform. Factors such as number of lanes, traffic congestion and access control also had marked effects on driver

behavior. For example, it was found that an average following time of 28 seconds was observed on 6-lane limited access highways. This climbed to 98 seconds for the same lane configuration when access control was absent. Similarly, following times on all city streets averaged 42 seconds under light-moderate traffic, and this rose to 70 seconds when traffic was moderate-heavy. However, there was then a drop to 38 seconds under heavy traffic conditions. Finally, pairings of observations of similar facilities under similar conditions indicated varying driver behavioral patterns -- when only area or weather were the variables.

Spin-Off

As a spin-off of the test observations, a considerable volume of average truck speed data was obtained and tabulated. These data, which showed a range of from 18.4 miles per hour for city streets to 55 miles per hour on rural Interstate routes, were found to correlate well with similar information published by the Federal Highway Administration. Variations from the Federal data were caused, for the most part, by the fact that observed speeds were obtained under actual traffic conditions. On the other hand, Federal speed data are reported to be based on free-running traffic on straight, level road sections.

One of the more interesting findings here was the effect of access control on average speeds of trucks. For example, on suburban arterial multilane highways, the average speed was found to be 51.5 miles per hour on controlled access facilities, but was only 32.5 miles per hour when access control was absent. Similar disparities were noted in rural and urban areas.

Utilization

The techniques developed and applied in obtaining the data contained in "The Visual Impact of Trucks in Traffic" can provide the researcher with a means of collecting a considerable volume of current, highly detailed, data with a minimum expenditure of time and money. A shortage of timely and pertinent data has always been one of the problems in the field of highway transportation. At the same time, collection of field data is usually both costly and time-consuming.

Therefore, this analysis technique is offered as a viable and reliable source document which may permit of substantial data enrichment. Copies of the full study, which includes a detailed procedure appendix and sample worksheets are available here today or by contacting either the author or the 3M Company.

SESSION IX

Forecasting Motor Carrier Demand and Equipment Requirements

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More Productive Trucks Can Reduce Exposure

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Forecasting Motor Carrier Traffic Demand and Equipment Requirements

By

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ABSTRACT

Alternative approaches to forecasting both the levels of motor carrier traffic and resultant new equipment demands are examined. Issues of data inconsistency and incompleteness are addressed and corrective procedures suggested. Estimation techniques best suited to traffic and equipment forecasting are evaluated in detail. In particular, new versions of stock-adjustment models used in equipment analyses are presented. Procedures to judgementally evaluate resultant forecasts are discussed. Finally, innovative techniques to consistently allocate forecasts of traffic levels to regional traffic flow patterns are presented. The presentation uses estimation and forecasting examples from an ongoing set of transportation traffic and equipment models develped and maintained by Data Resources.

DATA RESOURCES, INC.

FORECASTING MOTOR CARRIER DEMAND AND EQUIPMENT REQUIREMENTS

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and

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March, 1979

Background

As consultants to the motor carrier and truck equipment industry, Data Resources, Incorporated (DRI) maintains an extensive econometric model relating to future demand for truck (regulated and private) activity as well as required new and replacement equipment demands. DRI currently forecasts over 250 separate commodity traffic series by mode (rail, truck, water, pipeline, air) for the total U.S. market, including regional traffic movements for selected commodities. In addition, demand (new and replacement) for Class 6, 7, and 8 trucks and truck trailers (van, refrigerated van, platform, tank, bulkers, and other) are forecast. All series are projected on a quarterly basis, both short term (to 1981) and long term (to 2000). Vehicle miles travelled is an important measure of fleet productivity and capacity utilization, both of which are determinants of truck and trailer demand.

The paper describes the DRI truck activity and equipment demand models as well as discussing various applications of the forecasts in transportation industry planning. Problems associated with using vehicle miles travelled data in the models are also discussed, as are difficulties in reliably in forecasting vehicle miles data.

Role Of Vehicle Miles Data In Forecasting

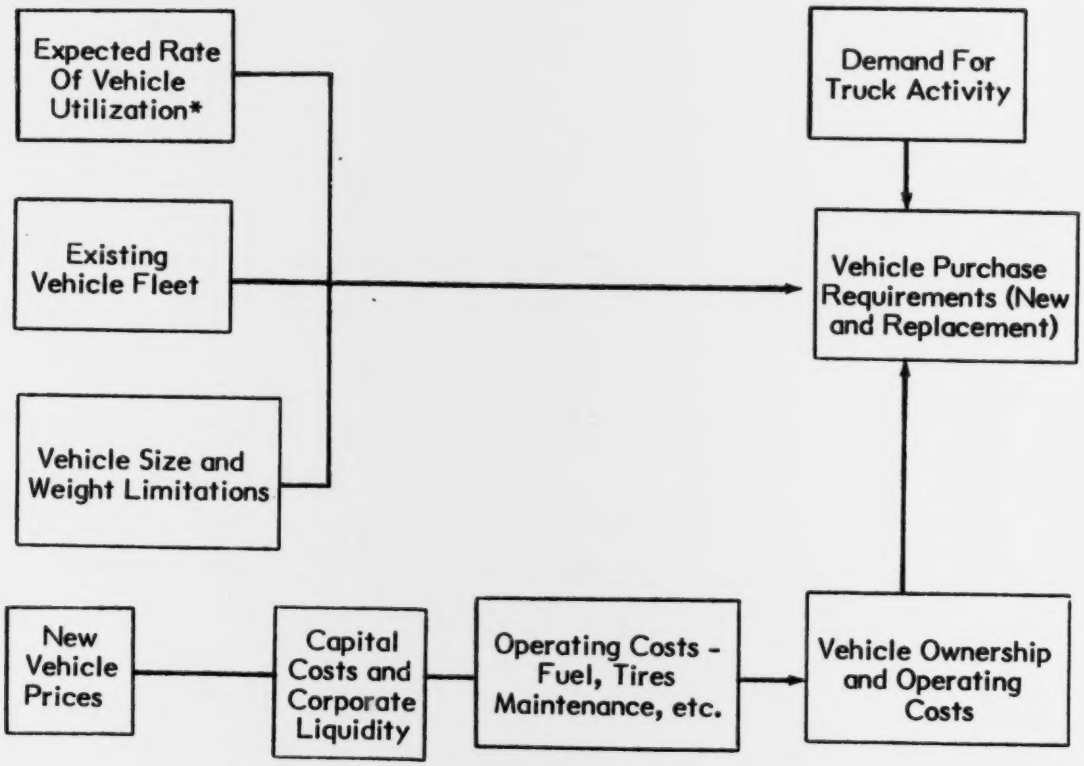
Before discussing in detail the models and forecasts, a generic examination of how vehicle miles data is used in the analysis of vehicle demand is relevant. Vehicle miles travelled is an important measure of capital stock (truck fleet) utilization in the economy and thus is a major determinant of new vehicle requirements by motor carriers and other sectors.

The DRI vehicle equipment demand models are basically capital stock-adjustment models. In this formulation, the actual capital stock (vehicle fleets) are adjusted (via new equipment purchases) towards a desired truck fleet, as measured indirectly by changing demands for truck traffic activity. Chart 1 depicts the relationship between the major explanatory factors and vehicle demand. New vehicle purchases are influenced by the existing vehicles in operation (fleet minus equipment in storage), the rate of vehicle utilization (measured by existing vehicle productivity), changes in vehicle size and weight limitations, demand for truck traffic (relative to other modes), and vehicle ownership and operating costs. In addition, purchasing behavior by non-motor carrier sectors, such as governmental and export sales as well as lease/rental markets is also considered. Finally, where special market situations exist, such as the competition between Class 3 and Class 6 trucks for the intra-urban delivery market, these are explicitly included in the vehicle modelling.

In accordance with economic theory on how vehicle demand responds to activity measures, both vehicle miles travelled and truck traffic demands are independently included in the analysis. However, a substantial degree of simultaneity exists between vehicle miles and traffic demand. In essense, vehicle miles travelled directly depends on traffic demand as well as shifts in origin and destinations of commodity flows, changes in backhaul regulations, circuity of trips, among other factors. Some analysts thus argue that ton-miles should be the principal explanatory variable in the vehicle demand equations. DRI prefers to formulate equipment demand models that

Chart I

Vehicle Equipment Demand


Expected Rate Of Vehicle Utilization*
Existing Vehicle Fleet
Vehicle Size and Weight Limitations
Demand For Truck Activity
Vehicle Purchase Requirements (New and Replacement)
New Vehicle Prices
Capital Costs and Corporate Liquidity
Operating Costs - Fuel, Tires Maintenance, etc.
Vehicle Ownership and Operating Costs

*Vehicle Fleet times Fleet Utilization, where utilization is measured by actual vehicle miles travelled relative to potential vehicle miles travelled.

separately account for traffic demand and vehicle productivity, rather than confusing their influence in a single variable such as ton-miles. Trucks and trailers must move a given tonnage a certain distance in order to complete the transportation production relationship. A carrier generally consider both expected traffic and potential miles per vehicle in deciding whether to alter existing fleets. If higher levels of empty backhaul are expected as the result of the additional traffic, such a factor would not be reflected in a ton-mile measure. However, vehicle miles include both loaded and empty trips, best indicating equipment utilization. Substantial care must be exercized in the modelling process to protect against vehicle miles and tonnage variables interfering with their independent influence on equipment demand. Finally, it is important to understand that measurement problems in vehicle miles data far outweigh specification problems that may exist in the models. This subject will be discussed in more detail in future sections of the paper.

Demand For Truck Traffic

The availability and quality of traffic information on truck activity in the U.S. has been a major constraint on modelling and forecasting modal commodity movements. There is not quarterly or annual source of truck data published that can directly be used in analyzing truck traffic. While the ICC publishes the annual Freight Commodity Statistics for Class I truckers, the data suffers from changes in the composition of the reporting group due to changing reporting requirements and changing size of many trucking firms, making cross temporal comparisons impossible. For example, major traffic declines are indicated when economic activity and trucking are known to be increasing. To make matters worse, the data has been published only for 1966 to 1974, due to the difficulty for motor carriers to translate their commodity traffic reporting system, the National Motor Freight Classification codes to STCC codes. Even if the series were more complete, regulated motor carriers account for only a fraction of the nation's truck traffic, with the remainder being hauled by non-reporting Class II and III motor carriers and private and exempt haulers.

DRI has tried to fill the gap by developing total truck activity indexes for specific commodity groups. These indexes are constructed from total shipments and foreign trade information for specific industries, coupled with data concerning complementary and competitive rail, water, pipeline, and air transportation. The indexes are benchmarked, when possible, on other sources, such as direct industry information and the Census of Transportation.

While the total truck indexes provide excellent information on truck activity by specific industries, their application to equipment modelling is limited by their annual base. Quarterly traffic measures better capture turning points in truck activity within a year, making vehicle demand models more useful to the industry. Unfortunately, it is currently impossible to construct total truck activity measures on a quarterly basis, due to specific data limitations.

As an alternative, the American Trucking Association (ATA) publishes a quarterly Intercity Truck Tonnage report which is based on a sample of Class I and II motor carrier reports submitted to the ICC. The ATA tabulates both tonnage and vehicle miles travelled for the current quarter and the same quarter a year ago for a number of carrier groups including general

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freight carriers and selected specialized carrier groups - household goods, building materials, motor vehicles, refrigerated products, among others. The composition of the sample for each group changes from quarter-to-quarter and year-to-year, so that the tonnage and vehicle miles figures themselves have little meaning. The ATA points out that only the percentage change from the previous year has any validity - because it compares the same group in both instances - and that figures cannot be used for inter-quarter comparisons within the same year. Certain data errors appear to enter the reports over time and are propagated thereafter by the chain-link procedures used to join year-to-year results. When the annual growth rates from the first quarter of one year to the first quarter of the next (as reported in the ATA publication) are linked in a "first quarter index" and the same is done for consecutive second, third and fourth quarters, one might expect to find four indexes which follow the same basic patterns, with differences in any one year being a function of the timing of the business cycle or specific industry shocks. Seasonality should not be an issue, since each index is essentially a seasonally adjusted index. If a particularly bad first quarter - as indicated by a decline from year ago traffic levels - occurs due to inclement weather or strike, a compensating increase would be expected in the first quarter of the following year. If the chain-linked ATA quarterly indexes are compared, however, the different quarters diverge sharply from each other at various points in time and remain apart, even though they continue to respond to appropriate economic forces at their new levels.

In a special application of the DRI seasonal adjustment package, the four "quarterly indexes" for each carrier groups are merged into a consecutive quarter-to-quarter index under the assumption that any appearance of persistent seasonality in these nonseasonal indexes is an indication of propagated stochastic errors.

The resulting indexes, which form the basis of the DRI quarterly truck traffic forecasts and truck/trailer equipment demand forecasts, have both advantages and disadvantages.

- On the positive side, the DRI adjusted indexes allow comparisons of quarter-to-quarter and year-to-year swings in motor carrier activity. The indexes pass an important test - their historical movements track well with proper measures of truck activity in related industries.

- On the negative side, the indexes cannot easily be compared with new data as it becomes available. Forecast error could be due to data errors or problems with the models. Benchmarking on a continuous basis is necessary to assure the indexes are tracking with reality in the motor carrier industry.

- The ATA reports truckers by specialized carrier groups rather than by commodity. Carriers which haul multiple commodities are assigned to that class which makes up their principal tonnage, rather than dividing tonnage correctly among groups.

In spite of these shortcomings, DRI believes that the adjusted ATA truck indexes are the best forecast indicators available for Class I and II motor carrier activity.

In order to forecast these indicators of truck traffic, DRI uses four major sets of explanatory factors

- Industry Activity Measures
- Foreign Trade
- Inventory Changes
- Modal Competition

to forecast the following carrier groups

- General Freight
- Household Goods
- Heavy Machinery
- Motor Vehicles
- Refrigerated Products
- Liquid Petroleum
- Agricultural Commodities
- All Other Commodities
- Building Materials
- Total, All Commodities

The final category - total, Class I and II motor carrier index - is a weighted sum of the preceding indexes. The weights used are based on the 1977 vehicle miles travelled by carrier groups instead of tonnage. Since the series are primarily used to forecast equipment demand, the index should account for classes of activity that generate relatively more vehicle miles than tons, since this more precisely measures truck operation impacts on new vehicle demand. For example, 46% of vehicle miles are generated by general freight operations in 1977, versus 32% of total tons in general freight activtiy. DRI prefers the index to be weighted by operational rather than tonnage factors, which tends to downplay weight relative to miles of haul. The rationale is that higher mileage movements will result in more rapid replacement of vehicles than heavier tonnage flows. Chart II summarizes the current DRI forecast for Class I and II motor carrier activity and depicts the forecast for general freight traffic under the two current DRI Macro Model scenarios, CONTROL (mild recession) and DEEPRECESSION. These forecasts are direct inputs into the truck and trailer equipment models, to be discussed in the following sections.

Heavy-Duty Truck Demand Model

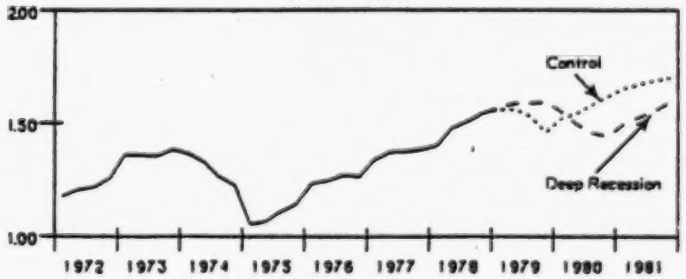
DRI forecasts the demand for Class 6, 7, and 8 trucks using a stock adjustment modelling procedure that incorporates flexible fleet retirement and utilization policies. In order to differentiate between over-the-road tractors and trucks versus non-highway or other vehicles (such as dump trucks and garbage trucks), the model splits the forecast into highway versus other vehicles using trends in truck traffic relative to alternate use activity measures in the projection period. The models forecast both retail and factory sales as well as diesel engine shares by class. Truck fleet by class is also forecast for use in the retail sales equations.

Chart II

Class I & II Motor Carrier Tonnage Indexes
(1966 = 1.00)

	1978	1979				Annual			
	IV QTR	I QTR	II QTR	III QTR	IV QTR	1978	1979	1980	1981
All Commodities									
Control	1.726	1.735	1.731	1.698	1.621	1.674	1.697	1.741	1.848
Deep Recession	1.726	1.747	1.763	1.764	1.767	1.674	1.760	1.653	1.708
General Freight									
Control	1.552	1.562	1.551	1.530	1.459	1.502	1.528	1.565	1.677
Deep Recession	1.552	1.571	1.588	1.588	1.594	1.502	1.585	1.485	1.542
Household Goods									
Control	2.289	2.340	2.351	2.361	2.337	2.217	2.347	2.414	2.583
Deep Recession	2.289	2.353	2.390	2.425	2.444	2.217	2.403	2.257	2.339
Heavy Machinery									
Control	2.970	2.980	2.971	2.927	2.834	2.910	2.928	2.925	3.057
Deep Recession	2.970	2.989	2.994	2.990	2.971	2.910	2.986	2.736	2.745
Motor Vehicles									
Control	1.770	1.720	1.670	1.539	1.264	1.683	1.548	1.677	1.664
Deep Recession	1.770	1.748	1.724	1.691	1.667	1.683	1.707	1.539	1.576
Building Materials									
Control	1.978	1.977	1.959	1.928	1.896	1.973	1.940	1.957	2.094
Deep Recession	1.978	1.989	2.000	2.009	2.016	1.973	2.003	1.923	1.968
Liquid Petroleum									
Control	1.739	1.743	1.746	1.728	1.688	1.688	1.726	1.750	1.828
Deep Recession	1.739	1.759	1.787	1.800	1.821	1.688	1.792	1.695	1.731
Agricultural Commodities									
Control	2.231	2.266	2.283	2.300	2.308	2.201	2.289	2.380	2.478
Deep Recession	2.231	2.275	2.295	2.317	2.337	2.201	2.306	2.352	2.428
All Other Commodities									
Control	1.800	1.818	1.812	1.777	1.697	1.749	1.776	1.826	1.946
Deep Recession	1.800	1.830	1.845	1.843	1.837	1.749	1.839	1.729	1.792

DRI Adjusted Truck Tonnage Index
Class I & II Motor Carriers of General Freight
(1967 = 1.00)



In general, truck demand by class depends on the following determinants:

- demand for truck activity (regulated, private, exempt)
- other demands (government, export)
- actual truck fleet
- fleet utilization
- cost of operation/ownership
- other influences (rail TOFC traffic, size and weight shifts)

Chart III sumamrizes the principal interactions of the explanatory variables and retail truck sales in the model. Retail truck sales by class are converted to factory sales data by examining dealer sales and stock levels, since producers ship from factories to both satisfy market demand and replenish dealer inventories. Diesel shares by truck class are a function of relative gasoline versus diesel fuel prices as well as initial purchase costs of a gasoline or diesel engine truck. The modelling process is as follows: First, a total demand for heavy-duty trucks is determined for Class 6, 7, and 8 vehicles. The rationale is that the total market moves in quite similar cycles and that many purchase decisions are influenced by the same factors, such as service demand, costs and fleet utilization. Next, the demand for Class 8 vehicles is estimated separately, in that many of these vehicles are over-the-road tractors used in intercity trucks haulage, a fairly unique market in substantial competition with long-haul rail traffic. Besides the standard factors, changes in truck size and weight limitations are explicitly included. Finally, Class 6 and 7 truck demand is determined, with substantial consideration of reclassification and historical trends between the classes. In addition, the competition to Class 6 vehicles from Class 3 trucks for use in urban delivery service is considered. For all classes, separate analysis of other-than-motor carrier demands are conducted.

Special study is also afforded to vehicle retirement policy by class. Data restrictions affect the reliability of Class 6 truck retirement rates, although Class 7 and 8 vehicles have fairly good scrappage information. The R. L. Polk data on total trucks in operation by manufacturer and model year is used to calculate depreciation rates. Chart IV contains the remaining percent-in-operation in years following model year for Class 8 Mack trucks. Similar charts are also developed for White, Peterbuilt, and Kenworth vehicles. Using assorted techniques involving fleet-weighted retirement averages and scrappage rates that vary across time, the retirement curves are employed in the calculation of fleet data by size class. A recent phenomena in vehicle scrappage policy bears discussion. Since 1970, due partly to more reliable vehicles and partly to higher retail prices, fleet owners have been keeping their equipment for longer periods. This "low replacement" cycle has approximately 88% of the 1971 to 1975 vehicles in operation compared to earlier "normal replacement" cycles which would have had only 80% of these vehicles still on the road. DRI has estimated vehicle demands in the future based on both normal and low replacement scrappage policies. All retail, factory sales and diesel truck information is provided by the Motor Vehicles Manufacturers Association.

Chart III

Class 6, 7, 8
Truck Demand
Model Flowchart

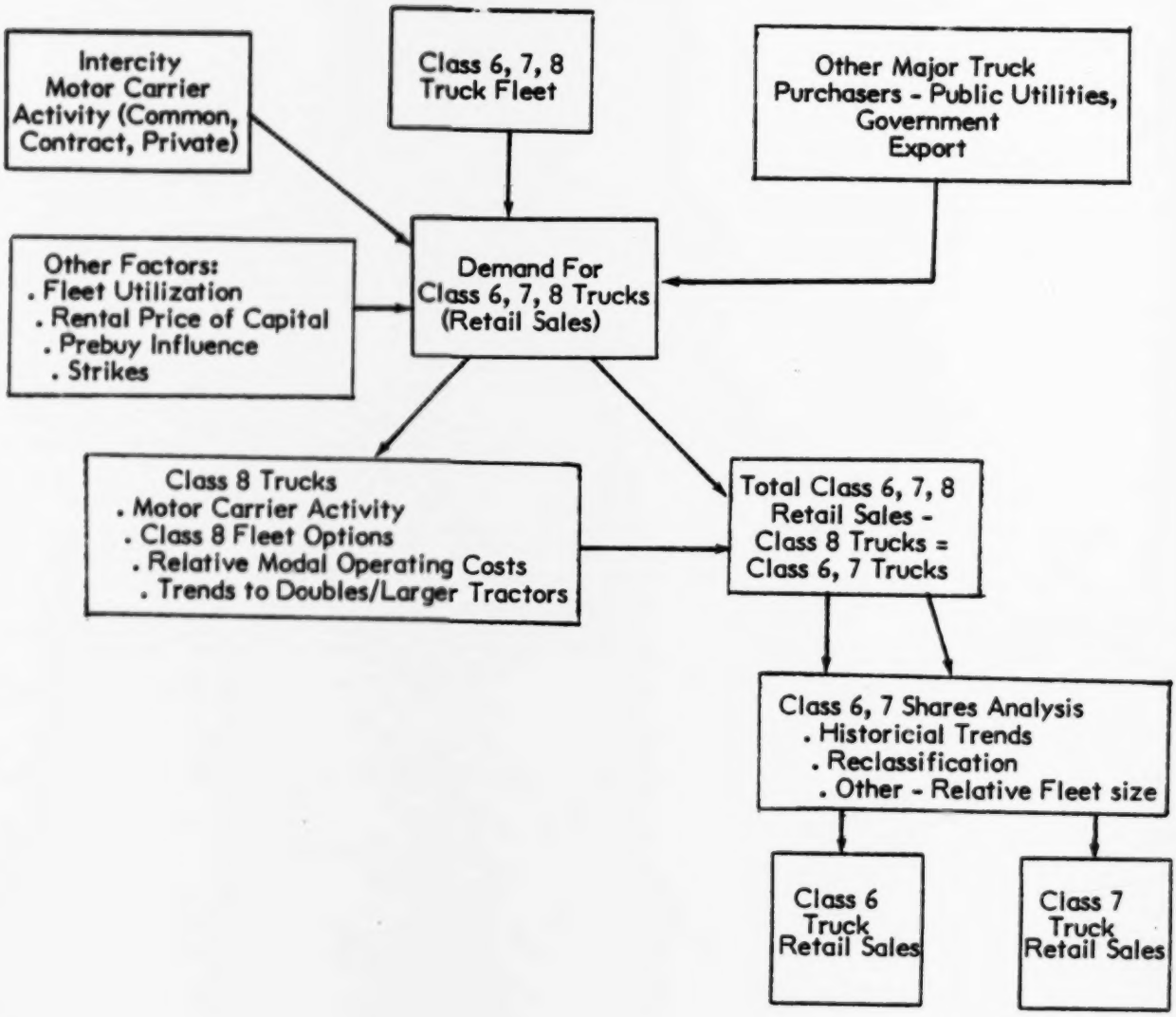

Intercity Motor Carrier Activity (Common, Contract, Private)
Class 6, 7, 8 Truck Fleet
Other Major Truck Purchasers - Public Utilities, Government Export
Other Factors:
. Fleet Utilization
. Rental Price of Capital
. Prebuy Influence
. Strikes
Demand For Class 6, 7, 8 Trucks (Retail Sales)
Class 8 Trucks
. Motor Carrier Activity
. Class 8 Fleet Options
. Relative Modal Operating Costs
. Trends to Doubles/Larger Tractors
Total Class 6, 7, 8 Retail Sales - Class 8 Trucks = Class 6, 7 Trucks
Class 6, 7 Shares Analysis
. Historicial Trends
. Reclassification
. Other - Relative Fleet size
Class 6 Truck Retail Sales
Class 7 Truck Retail Sales

Chart IV

Mack - Class 8 Truck Scrappage by Model Year
(% remaining in operation)

Years From Model Year	Model Year 1956	Model Year 1957	Model Year 1958	Model Year 1959	Model Year 1960	Model Year 1961	Model Year 1962	Model Year 1963	Model Year 1964	Model Year 1965	Model Year 1966	Model Year 1967	Model Year 1968	Model Year 1969	Model Year 1970	Model Year 1971	Model Year 1972	Model Year 1973	Model Year 1974	Model Year 1975
1.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2.	1.000	1.003	0.972	0.992	1.005	0.960	0.978	0.943	1.001	1.012	0.959	0.973	0.945	1.000	0.993	0.943	1.028	0.989	0.987	0.980
3.	0.995	0.964	0.975	1.008	0.996	0.934	0.945	0.943	1.005	0.914	0.921	0.935	0.911	0.951	0.972	0.954	1.010	0.960	0.977	
4.	0.935	0.962	0.978	0.969	0.928	0.897	0.905	0.898	0.933	0.911	0.907	0.918	0.865	0.922	0.993	0.929	0.948	0.940		
5.	0.941	0.961	0.929	0.901	0.908	0.875	0.882	0.823	0.890	0.867	0.857	0.881	0.847	0.938	0.909	0.885	0.932			
6.	0.925	0.898	0.905	0.871	0.906	0.829	0.819	0.802	0.851	0.820	0.823	0.831	0.836	0.898	0.865	0.847				
7.	0.874	0.843	0.854	0.876	0.845	0.788	0.798	0.751	0.777	0.761	0.766	0.824	0.797	0.826	0.831					
8.	0.821	0.792	0.795	0.801	0.762	0.747	0.732	0.668	0.717	0.723	0.740	0.776	0.728	0.796						
9.	0.734	0.744	0.715	0.713	0.711	0.683	0.648	0.707	0.657	0.666	0.675	0.707	0.693							
10.	0.687	0.652	0.640	0.655	0.658	0.599	0.574	0.543	0.598	0.579	0.601	0.657								
11.	0.610	0.583	0.582	0.593	0.569	0.507	0.513	0.490	0.522	0.500	0.559									
12.	0.529	0.520	0.517	0.500	0.483	0.465	0.461	0.417	0.444	0.446										
13.	0.458	0.459	0.431	0.420	0.431	0.402	0.387	0.357	0.401											
14.	0.406	0.376	0.364	0.366	0.374	0.346	0.323	0.316												
15.	0.398	0.317	0.316	0.320	0.314	0.286	0.302													

Source: DRI Transportation Service

A problem associated with using vehicle miles data in the estimation process is the difficulty in obtaining complete data for all truck operations. At present, Class I and II motor vehicle miles driven estimates are used as proxies for total vehicle miles driven. Also, no temporal vehicle miles data exists for trucks by size class. Although the Truck Inventory and Use Survey contains episodic information on truck operations, the source is not sufficient to base trend analysis or drive quarterly models. Even the existing vehicle miles data suffers from the same defects as the motor carrier tonnage data described in the previous section (e.g., they are not linked quarter-to-quarter over time, instead are current quarter versus same quarter last year). DRI has to modify the vehicle miles series published by ATA in order to use them in estimating utilization. Calculation of potential vehicle-miles is accomplished by multiplying estimated feasible miles per vehicle times existing fleet. Fleet utilization is calculated as actual vehicle miles divided by potential vehicle miles in any quarter.

Typical applications of the heavy-duty truck models are for industry production cycle planning, both for complete vehicles and components and for physical system (highways, terminals, repair facilities, gas stations, among others) construction forecasts. In additon, oil companies use the output in planning relative shares of gasoline versus diesel fuel for future truck market demands. The Department of Transportation is currently using the model output to improve existing vehicle miles travelled models by using the DRI truck activity and fleet forecasts. Finally, a number of foreign truck and engine producers are using the models in market penetration studies. Improvements to the models in the future will include better specification of other-than-motor carrier demand for trucks in the models, especially the export market for U.S. vehicles and parts.

Chart V contains the most recent DRI forecasts of the heavy-duty truck market through 1981. Sales in 1979 are expected to fall somewhat due to the projected recession, then recover through 1980 and 1981.

Chart V

Heavy-Duty Truck Retail Sales
(thousands of units)
(Seasonally Adjusted - Annual Rates)

	1978	1979	1980	1981
Class 6	.157	.158	.171	.177
Class 7	.40	.34	.40	.37
Class 8	.162	.159	.167	.180
Total, All Classes	.359	.351	.372	.384

Source: DRI Transportation Service
DRI Macro Model, CONTROL0122 Scenario

DRI publishes a semi-annual Transportation Equipment Review in which these forecasts as well as rail industry forecasts of equipmet are discussed in greater detail.

Truck Trailer Demand Model

The DRI truck trailer models estimate total factory sales of new truck trailers by class; van, refrigerated van, platform, tank, bulker, and other. Primary data sources include the Department of Commerce, Truck Trailer Shipments, ML-37 series and Department of Commerce, Exports - Schedule B codes - of truck trailers by type. The models analyze the complete order/delivery/inventory adjustment cycle. Sincy only factory sales are available for analysis, the equations must consider both final demand and dealer inventory factors. Although actual determinants vary somewhat by class of trailer, the following general explanatory factors are used:

- demand for truck activity
- off-highway trailer demand (dump bodies, containers)
- trailer fleet
- trailer size/height standards
- fleet utilization
- inventory policy
- trailer prices
- NHTSA brake standard No. 121 impacts
- modal factors (rail TOFC, Road Railer units)

Calculation of trailer fleets by class are determined using estimates of both trailer retirements and trailers in storage. The latter factor is quite important in trailers since they last about twice as long as trucks. Also, they are often used as portable storage facilities that can be brought into service during peak periods. During normal economic conditions, many of these older trailers are not in use but often counted in trailer fleet estimates. DRI has corrected trailer fleet data to reflect this phenomena. Chart VI compares the DRI trailer fleet estimates to alternative sources:

Chart VI

Total Trailer Fleet Estimation
(Trailers in Operation)

	1975	1976
Commercial Car Journal[1]	NA	2,275,860
FHWA[2]	2,577,562	2,764,090
DRI[1]	1,686,380	1,739,337

[1] All types, except detachables - DRI excludes all units greater than 27 years old

[2] All types, trailers and semi-trailers including detachables

The DRI estimates are very close to the data for trailers in operation generated by R. L. Polk, which includes only trailers registered and in operation. In general, trailer retirement rates average only 4% per year, about half the 7% to 8% rate for heavy duty trucks.

Other important explanatory factors include trailer size/height limits, inventory policies, trailer prices, and utilization as well as the brake anti-lock standards. DRI has developed a trailer length and size index which is used to correct new vehicle sales (in a hedonic sense) for greater payload per unit. Such a factor is quite important, since a 1967 trailer is not the same as a 1977 trailer, given that length has, on average, increased from 37 to almost 50 feet and height has grown to over 13 feet. Since DRI has only factory sales data, a special inventory variable had to be constructed for truck trailers using truck dealer inventories as a proxy. Utilization is measured using the same series employed in the truck model, with total fleet multiplied by potential versus actual vehicle miles travelled. An important consideration is the so-called 1974 trailer "pre-buy" in anticipation of the NHTSA Brake Standards No. 121. Substantial trailer purchases occured to avoid higher purchase prices and allegedly faulty anti-lock devices.

Trailer prices are also an important explanatory variable, measuring the response of demand to relative trailer sale value shifts. Finally, various modal factors, such as the influence of rail TOFC traffic on purchases of new van trailers are also included. Modal competition for traffic between rail and truck is analyzed in the DRI traffic models.

Specific demand indicators for each trailer-type market are developed. For example, platform trailer sales depend on building materials demands, steel product shipments and agricultural commodity movements. The export market is also important for platform and tank trailer sales.

DRI is currently undertaking special analyses of two major factors that may affect the trailer market; the influence of rail TOFC market growth on van demands and impacts of deregulation on trucking markets.

Major applications of the DRI truck trailer model include production planning, inventory management, component/material substitution mix analysis, market analysis (including regional shifts in trailer demand), among others. DRI currently is expanding its trailer data bases to include trailer exports by month by type, and country of destination in order to expand its analysis capability to foreign markets.

The DRI models all have a long-term simulation capability. Chart VII contains annual trailer shipment forecasts by type to 1995. The trailer model also is used for short-term quarterly analysis to 1981 for strategic planning purposes.

In sum, DRI makes extensive use of available vehicle miles data in forecasting truck and trailer demand. However, the shortcomings of existing vehicle miles travelled data make its applicability in vehicle modelling questionable at best. Consistent, temporal estimates of vehicle operations by type of operator would substantially improve the ability of forcasters to estimate vehicle utilization, so important in capital productivity studies in vehicle fleets. Although the Truck Inventory and Use Survey provides valuable, updated information every five years, one cannot model in 1979 using 1972 data as a basis. Truck and trailer fleets are some of the largest capital stocks in society and little is directly known about their utilization over time. Forecasters could substantially improve their estimates of new vehicle demand if better measures of vehicle miles of operation were available.

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Chart VII

TRUCK TRAILERS BY TYPE
FACTORY SHIPMENTS FORECASTS

SCENARIO - TRENDLONG2003

	1978	1979	1980	1981	1982	1983	ANNUAL 1984
TRUCK TRAILERS,TOTAL							
FACTORY SHIPMENTS,ALL TYPES-SAAR	183,237	166,965	183,145	199,793	199,256	211,395	232,828
AVERAGE VALUE PER UNIT SHIPPED-$	10,439	11,642	12,396	13,046	14,026	15,022	15,920
TRUCK TRAILER FLEET,ALL TYPES(ESTIMATED)	2,023,497	2,137,122	2,222,896	2,318,747	2,426,672	2,542,984	2,668,706
TRUCK TRAILERS,VANS							
FACTORY SHIPMENTS,VANS-SAAR	119,264	107,779	118,793	132,164	131,395	138,587	153,216
AVERAGE VALUE PER UNIT SHIPPED-$	10,095	11,244	11,976	12,510	13,431	14,388	15,212
TRUCK TRAILER FLEET,VANS(ESTIMATED)	1,209,866	1,288,463	1,347,575	1,415,124	1,492,245	1,572,174	1,657,899
FACTORY SHIPMENTS,REFRIGERATED VANS-SAAR	16,743	15,636	16,740	17,992	18,360	19,226	20,557
TRUCK TRAILERS,PLATFORMS							
FACTORY SHIPMENTS,PLATFORMS-SAAR	29,653	28,754	29,783	33,572	33,723	36,025	40,724
AVERAGE VALUE PER UNIT SHIPPED-$	7,075	7,716	8,350	8,872	9,464	10,126	10,789
TRUCK TRAILER FLEET,PLATFORMS(ESTIMATED)	353,141	373,086	388,574	405,237	423,647	443,079	464,824
TRUCK TRAILERS,OTHER							
FACTORY SHIPMENTS,ALL OTHER-SAAR	34,440	30,445	34,620	34,065	34,155	36,811	38,923
TRUCK TRAILER FLEET,OTHER(ESTIMATED)	460,489	475,574	486,747	498,386	510,780	527,731	545,982
KEY EXPLANATORY FACTORS (MILLIONS OF UNITS/$-SAAR) (1967=1.00 FOR INDEXES)							
INTERCITY TRUCK ACTIVITY INDEX,TOTAL	1.668	1.685	1.769	1.877	1.905	2.001	2.132
INTERCITY TRUCK INDEX,GENERAL FREIGHT	1.495	1.520	1.603	1.713	1.731	1.815	1.943
INTERCITY TRUCK INDEX,REFRIG.PRDCTS	2.310	2.405	2.518	2.630	2.743	2.855	2.968
INTERCITY TRUCK INDEX,BLDG.MATERIALS	1.973	1.911	2.004	2.099	2.127	2.234	2.346
DURABLE EQUIPMENT EXPENDITURES-U.S.(72$)	95.462	97.276	101.486	107.425	110.047	114.693	122.690
RENTAL PRICE OF CAPITAL-EQUIPMENT	0.329	0.338	0.359	0.390	0.410	0.432	0.452
HOUSING STARTS,PRIVATE-TOTAL	1.984	1.709	2.020	1.960	1.959	2.202	2.271
WHOLESALE PRICE INDEX-TRANS. EQUIPMENT	1.310	1.926	2.036	2.149	2.273	2.413	2.557
INDEX-TRAILER SALES TO CLASS 7,8 TRUCK SALES	0.94	0.92	1.00	1.00	1.00	1.00	1.00
INDEX OF AVERAGE TRUCK TRAILER LENGTH	1.24	1.27	1.28	1.31	1.33	1.35	1.36

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Chart VII

TRUCK TRAILERS BY TYPE
FACTORY SHIPMENTS FORECASTS

SCENARIO - TRENDLONG2003

	1985	1986	1987	1988	1989	1990	1991
TRUCK TRAILERS,TOTAL							
FACTORY SHIPMENTS,ALL TYPES-SAAR	259,703	280,600	294,210	307,782	317,341	327,701	316,947
AVERAGE VALUE PER UNIT SHIPPED-$	16,747	17,666	18,766	19,995	21,316	22,709	24,200
TRUCK TRAILER FLEET,ALL TYPES(ESTIMATED)	2,808,450	2,978,821	3,157,557	3,339,863	3,523,678	3,707,207	3,880,814
TRUCK TRAILERS,VANS							
FACTORY SHIPMENTS,VANS-SAAR	172,451	188,013	198,066	207,445	213,764	220,658	213,247
AVERAGE VALUE PER UNIT SHIPPED-$	15,933	16,730	17,721	18,860	20,100	21,409	22,811
TRUCK TRAILER FLEET,VANS(ESTIMATED)	1,753,327	1,869,869	1,992,282	2,118,261	2,246,771	2,375,009	2,494,508
FACTORY SHIPMENTS,REFRIGERATED VANS-SAAR	22,175	23,564	24,608	25,611	26,422	27,269	27,222
TRUCK TRAILERS,PLATFORMS							
FACTORY SHIPMENTS,PLATFORMS-SAAR	45,213	48,936	51,324	53,087	54,519	55,963	57,244
AVERAGE VALUE PER UNIT SHIPPED-$	11,439	12,121	12,868	13,681	14,551	15,472	16,454
TRUCK TRAILER FLEET,PLATFORMS(ESTIMATED)	490,150	520,712	553,117	586,002	618,460	650,201	682,356
TRUCK TRAILERS,OTHER							
FACTORY SHIPMENTS,ALL OTHER-SAAR	42,082	43,687	44,849	47,278	49,088	51,111	46,482
TRUCK TRAILER FLEET,OTHER(ESTIMATED)	564,973	588,240	612,157	635,600	658,448	681,997	703,950
KEY EXPLANATORY FACTORS (MILLIONS OF UNITS/$-SAAR) (1967=1.00 FOR INDEXES)							
INTERCITY TRUCK ACTIVITY INDEX,TOTAL	2.270	2.393	2.488	2.582	2.679	2.782	2.888
INTERCITY TRUCK INDEX,GENERAL FREIGHT	2.086	2.214	2.307	2.396	2.489	2.589	2.691
INTERCITY TRUCK INDEX,REFRIG.PRDCTS	3.080	3.193	3.305	3.418	3.530	3.643	3.755
INTERCITY TRUCK INDEX,BLDG.MATERIALS	2.421	2.487	2.539	2.605	2.667	2.727	2.785
DURABLE EQUIPMENT EXPENDITURES-U.S.(72$)	132.261	141.475	148.820	154.804	160.122	165.575	170.824
RENTAL PRICE OF CAPITAL-EQUIPMENT	0.469	0.490	0.512	0.537	0.564	0.594	0.625
HOUSING STARTS,PRIVATE-TOTAL	2.210	2.136	2.098	2.103	2.086	2.069	2.034
WHOLESALE PRICE INDEX-TRANS. EQUIPMENT	2.699	2.849	3.008	3.178	3.356	3.545	3.745
INDEX-TRAILER SALES TO CLASS 7,8 TRUCK SALES	1.00	1.00	1.00	1.00	1.00	1.00	1.00
INDEX OF AVERAGE TRUCK TRAILER LENGTH	1.36	1.37	1.39	1.39	1.40	1.41	1.52

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Chart VII

TRUCK TRAILERS BY TYPE
FACTORY SHIPMENTS FORECASTS

SCENARIO - TRENDLONG2003

	1992	1993	1994	1995
TRUCK TRAILERS,TOTAL				
FACTORY SHIPMENTS,ALL TYPES-SAAR	325,244	332,285	322,093	333,767
AVERAGE VALUE PER UNIT SHIPPED-$	25,765	27,379	29,051	30,798
TRUCK TRAILER FLEET,ALL TYPES(ESTIMATED)	4,047,651	4,220,721	4,378,608	4,528,610
TRUCK TRAILERS,VANS				
FACTORY SHIPMENTS,VANS-SAAR	218,633	223,180	216,298	224,139
AVERAGE VALUE PER UNIT SHIPPED-$	24,287	25,810	27,386	29,031
TRUCK TRAILER FLEET,VANS(ESTIMATED)	2,609,321	2,729,025	2,836,199	2,937,038
FACTORY SHIPMENTS,REFRIGERATED VANS-SAAR	27,975	28,675	28,661	29,567
TRUCK TRAILERS,PLATFORMS				
FACTORY SHIPMENTS,PLATFORMS-SAAR	58,431	59,467	60,425	61,446
AVERAGE VALUE PER UNIT SHIPPED-$	17,492	18,566	19,674	20,827
TRUCK TRAILER FLEET,PLATFORMS(ESTIMATED)	715,256	748,523	780,466	812,515
TRUCK TRAILERS,OTHER				
FACTORY SHIPMENTS,ALL OTHER-SAAR	48,209	49,666	45,396	48,209
TRUCK TRAILER FLEET,OTHER(ESTIMATED)	723,074	743,173	761,942	779,058
KEY EXPLANATORY FACTORS (MILLIONS OF UNITS/$-SAAR) (1967=1.00 FOR INDEXES)				
INTERCITY TRUCK ACTIVITY INDEX,TOTAL	2.993	3.098	3.200	3.299
INTERCITY TRUCK INDEX,GENERAL FREIGHT	2.792	2.892	2.990	3.087
INTERCITY TRUCK INDEX,REFRIG.PRDCTS	3.868	3.980	4.093	4.205
INTERCITY TRUCK INDEX,BLDG.MATERIALS	2.836	2.873	2.928	2.977
DURABLE EQUIPMENT EXPENDITURES-U.S.(72$)	176.198	181.543	186.746	191.972
RENTAL PRICE OF CAPITAL-EQUIPMENT	0.657	0.691	0.726	0.762
HOUSING STARTS,PRIVATE-TOTAL	1.976	1.909	1.842	1.791
WHOLESALE PRICE INDEX-TRANS. EQUIPMENT	3.955	4.170	4.391	4.623
INDEX-TRAILER SALES TO CLASS 7,8 TRUCK SALES	1.00	1.00	1.00	1.00
INDEX OF AVERAGE TRUCK TRAILER LENGTH	1.54	1.57	1.68	1.68

MORE PRODUCTIVE TRUCKS CAN DECREASE EXPOSURE

by

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Abstract

More productive trucks can reduce exposure to accidents, noise and emissions while, at the same time, conserving fuel, benefitting the economy and reducing effects on highways and bridges. The more productive trucks referred to in this paper are multiple trailer combinations made by adding an additional trailer to present day conventional trucks or truck combinations. They are operated only by revocable term permits which require high standards of vehicle and driver performance and which restrict the routes of travel to those determined to have adequate geometric and structural capacity. Longer truck combinations have been operated successfully for many years on eastern and midwestern toll roads and in several western states. Increasing need and demand for goods transported over highways may require twice as many commercial trucks within the next 10 to 15 years unless more goods are carried per power unit. This factor, together with an impending fuel shortage, could make it imperative that more productive commercial vehicles be utilized at least on major intercity freight routes. Exposure data on present operations are limited except from a few large trucking companies, but the capacity to collect such data exists in the regulatory agencies which issue the permits.

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MORE PRODUCTIVE TRUCKS CAN DECREASE EXPOSURE

More productive trucks can decrease exposure. They can, under proper control and regulation, do more than decrease accident exposure on streets and highways. They can decrease exposure to vehicle noise, smoke, emissions, as well as decrease exposure of all road users to substandard driving and operational practices. Highway pavements and bridges can be exposed to fewer heavy axle loads and stresses of the magnitude that unduly hasten the breakup and failure of highway facilities. And last, but not least, significant savings of vital fuel supplies can be achieved.

It is easy to understand how, by carrying more payload per truck, greater productivity is achieved with fewer trucks. This would mean less truck exposure to other highway traffic. However, it isn't quite that simple. Just carrying more payload per power unit doesn't guarantee all the benefits stated previously. The productive truck must be defined and qualified. And recognition must be given to the fact that truck traffic on our nation's streets and highways is going to continue to increase in future years, that is, unless we all are willing to accept a much lower standard of living. I doubt that we are.

The progress and strength of our nation has been due, to a great extent, to its transportation systems and the ability to transport just about anything, or anyone, to any place in this country in an amazingly short time. Again, I doubt that many of us have the desire or the ability to stay home, grow our own food, make our own clothes, or do the hundreds of other tasks that would be necessary if the scope and efficiency of our transportation systems were drastically reduced. I think we all want to continue the good life and to keep on improving it.

Public and private economists, transportation specialists and other forecasters of what the future has in store for us certainly do not believe there will be any long range downturn in our economic growth. I have read numerous forecasts of our future highway needs. Some support a "no growth" policy; some promote a considerably expanded highway network. However, none appear to dispute the fact that future economic growth will require the movement of more goods by highway transport. All indications are that the amount of goods which will be hauled over our highways and streets will double by 1995. In a recent article published in Fleet Owner magazine, Mr. Robert D. Lund, vice president, General Motors Corporation, stated, "We expect that Americans will be consuming over four billion tons of goods and materials each year in the 1980's. By 1985 there will be 23 million more of us, and it will take more than 200 million trailer loads of goods and materials to supply that demand."

Intercity freight, one of the principal factors contributing to our nation's vigorous growth, is a large part of the total freight hauled by motor carriers. In 1975, a total of 590 billion ton-miles of freight was hauled by motor carriers. Of this, 450 billion ton-miles was intercity freight. By 1990, if we still have fuel, total motor carrier freight is expected to increase to just under one trillion ton-miles, of which nearly 90 percent, or 880 billion ton-miles, will be intercity freight.

The above figures on the anticipated increase in future truck traffic show that, barring unforeseen developments in transportation patterns, exposure to trucks on our streets and highways in the next 20 years is going to increase. The rate of increase could exceed even that quoted above with deregulation of the trucking industry and unlimited access to our highways for anyone who wants to buy, rent or lease a truck.

One immediate solution might appear to be rail transportation, but studies show that the amount of highway freight which could be diverted to rail would not significantly reduce the number of trucks needed to haul goods over highways. Rail transportation would have more effect on tonnage than on quantity. Equipment purchases now being made and which are projected by the rail industry bear this out. The emphasis apparently is toward the purchase of specialized equipment for high density freight such as coal, ore, steel and heavy manufactured products. Only a small percentage of new equipment includes box cars or refrigerated cars. This could result in even more light density freight required to be carried by highway transport.

What, then, can be done if we are not willing to accept such projected increases in highway truck exposure? There is no single answer short of returning to the life style of the early 1900's. Our greater population and its much wider distribution, the decentralization of our cities along with many other factors make it highly unlikely that we could, even if we wanted to, crank ourselves back in time to those so-called "good old days."

So, if we want to continue with the "good life" we must honestly consider — and I repeat, honestly consider — all ways of doing so with a minimum of adverse effects.

More productive highway transport is one way. This means not only more productive trucks, but also more productive highways, more productive operational procedures and more productive laws, rules and regulations governing highway transport. I feel sure that we don't want twice as many trucks on the highways in fifteen to twenty years from now if we can meet our economic needs safely and compatibly with fewer trucks.

Before I get back to defining and qualifying the more productive truck, I'd like to touch briefly on the other productivity factors which I just mentioned.

More productive highways. Good highway design and highway condition can reduce exposure. Important are such geometric features as uphill passing lanes, adequate storage lanes at intersections for turning movements (this means both in number and in length), adequate acceleration and deceleration lanes, parking areas at crests of steep grades where brakes can be checked, adequate curve radii for off and on ramps and for getting on or off interchanges, and adequate shoulders on which to park a disabled vehicle. These and other improvements in highway geometrics will reduce the exposure of trucks to the traffic stream. Better maintained and conditioned highways will reduce exposure. Traffic will flow more uniformly and the hours spent by trucks to get from origin to destination will be reduced.

Of course, the most productive highway system, and one offering the least exposure, would be one with separate truck lanes or a separate facility for trucks. This is not a new idea. It was proposed by the trucking industry when the interstate highway system was still in the talking stage. I was present in Chicago when a committee of highway officials reported that, in order to be able to build one highway facility to the proposed interstate standards, truck taxes would be needed. The proposal for separate truck roads financed by truck taxes was then discarded.

More productive laws, rules and regulations. Existing non-uniformity between states and between state and federal regulations governing highway transport require more trucks than necessary on the roads. Trucks are required to travel many additional miles to comply with restrictive regulations. All this results in much unneeded exposure.

More productive operational procedures. This includes the efficiency of operation, the ability of the driver, and the facilities provided for operation. Scheduling and routing to effect minimum hours and minimum miles on the road is important. The proper equipment, well maintained and conditioned, will reduce the number of breakdowns or slowdowns or other conditions which add to exposure. Well trained and capable drivers will help reduce exposure. Adherence to speed limits and other traffic laws will reduce exposure. Well located terminal facilities are a positive factor in reducing exposure. A long-range benefit could be realized from marshalling yards such as found on eastern tollroads.

Since I came to discuss more productive trucks, I'd better get back to the subject of my talk.

Western Highway Institute has been testing and researching more productive trucks for over three decades. About fifteen years ago, it was concluded that these efforts be directed specifically toward a truck combination which is created by adding another trailer unit to an existing commonly used truck configuration. The four basic combinations thus created which received most of our attention were: 1. Turnpike doubles which resulted from adding another 40-foot trailer to the very common 55-foot truck tractor-semitrailer combination; 2. Rocky Mountain doubles, made by adding a 27-foot box to the 55-foot tractor semi; 3. Triple trailer combination resulting from the addition of another 27-foot trailer to a conventional 65-foot twin trailer combination; and 4. Truck-trailer or truck-trailer-trailer combination made by adding a long trailer to a full truck or another short trailer to a truck-trailer combination.

These are immediate ways to increase the productivity of truck combinations by 50 to 100 percent (Exhibit 1). Theoretically, the number of trucks on the highway needed to carry an equal amount of goods would be reduced 50 to 100 percent. And, carrying it further, the exposure index would be reduced correspondingly.

However, the figures may be misleading because the productive truck configurations selected by WHI for extensive study had to be safe and be compatible with other highway traffic and with the highways over which they would travel. This meant axle loads and gross loads which would not unduly overstress pavements and bridges; operational characteristics such as braking, power, traction, stability, maneuverability, acceleration and splash and spray emissions which were safe and compatible; strict operational procedures to govern speed, loading, safety inspections and other controls; and last, but not least, stringent driver qualifications. The recommended routes of operation were narrowed down to four- or more lane highways or those two-lane highways which were approved by state highway authorities after an economic and engineering evaluation.

Thus, the more productive truck researched by Western Highway Institute evolved into a multiple trailer combination, commonly called a longer combination, operated under a revocable permit which specified allowable routes of travel, certain equipment components, loading practices, driver qualifications, operational characteristics and other conditions which would result in a highway operation as safe or, as it has turned out, safer than other trucks using that highway. But, because of the restrictions imposed upon the operation of these more productive trucks, not every truck operator can qualify nor is every type of commodity hauled physically or economically compatible with the restrictions imposed to protect pavements and bridges. But there still remains a tremendous opportunity to reduce exposure and to benefit this

country of ours by operating these more productive trucks wherever practical and feasible.

After years of testing and research the more productive truck adopted as one of WHI's objectives for improving highway transport has the following characteristics.

Width: 102 inches. A six-inch increase in width from 96 to 102 inches will greatly increase efficiency. Standard 96-inch wide materials such as plywood or other dimension products which add to 96 inches, including pallets, will not fit inside a 96-inch wide truck or trailer since the 96-inch limit is on the outer dimension, not the inside dimension. Trucks and trailers 102-inches wide will decrease the number of trucks required and will reduce exposure correspondingly.

Height: 14 feet. This height and even greater is allowed in several states at this time.

Length: 105 feet. The additional length created by adding another cargo unit is where the real increase in productivity is found. When operated under the rules and regulations recommended by Western Highway Institute, no appreciable adverse safety effect has been found resulting from the additional length. The triples can negotiate even tighter turns than can the conventional tractor-semitrailer combination and stop in a stable condition in shorter distances. Extra length has been proven to be an aid to stability. The safety record of the longer combinations is consistently better than any other truck configuration.

Weight: 20,000 pound single axles, 34,000 pound tandem axles and 105,500 gross controlled by a bridge formula. Federal studies and recommendations call for a 105,500 pound gross weight allowance on a 60-foot wheelbase. Longer combinations spread their load over a much greater distance thus reducing the effects of the load. The 105,500 pounds also is imposed on more axles on the longer combinations resulting in lighter axle loads which further benefit the highways.

Equipment: Some special specifications are required such as fast air transmission and release valves, no-slack pintle hooks, stiff suspension systems, etc. Exhibit 2 attached is a copy of WHI's model rules and regulations for the operation of longer combinations.

I could spend much more time on the empirical and scientific data which have proven the safety and compatibility of more productive longer combinations and their special adaptability to intercity highway transport, but I'll save that for possible questions.

Up to now, I have discussed longer combinations without mentioning another more productive truck configuration. This

is the twin trailer or doubles combination which is in regular operation in all the western states but which is prohibited in some states east of the western region. There is another great opportunity to decrease exposure by allowing nationwide operation of these safe and efficient combinations. A recently completed study, published as NCHRP Report No. 198 entitled "State Laws and Regulations on Truck Size, Weight and Speed" presents considerable data showing the decrease in accidents which can be effected by converting to more productive vehicles. The 65-foot twin trailer combination is included in the data.

In summary, let me revise the title of my talk from "More Productive Trucks Can Decrease Exposure" to "More Productive Trucks Will Decrease Exposure." The use of more productive trucks will result in fewer trucks required to meet the economic demands of our nation, both present and future. And fewer trucks on the highway means less exposure.

Better operational procedures, driver qualifications, equipment specifications and other safety controls will further reduce hours and miles of exposure as well as exposure to substandard driving and operational practices.

It is an exposure reduction program that the trucking industry could put into effect almost immediately. All the rest of us would have to do is to face the facts squarely. The groups which oppose more productive trucks because of selfish interests must substitute reason for emotion. Those who oppose due to a lack of knowledge should become acquainted with the facts. The facts are there and fully support the potential economic and safety benefits of properly operated, more productive trucks.

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Exhibit 1

Cubic Capacity of Cargo Units for Nine Typical Commercial Truck Combinations

1.	40 ft. (12.2m) long trailer	- 2,500 cu. ft. (70.8 cu. m.)
2.	45 ft. (13.7m) long trailer	- 2,900 cu. ft. (82.1 cu. m.)
3.	27 ft. (8.2m) long trailer	- 1,700 cu. ft. (48.1 cu. m.)
4.	twin 27 ft. (8.2m) trailers	- 3,400 cu. ft. (96.3 cu. m.)
5.	twin 40 ft. (12.2m) trailers	- 5,000 cu. ft. (141.6 cu. m.)
6.	twin 45 ft. (13.7m) trailers	- 5,800 cu. ft. (164.3 cu. m.)
7.	triple 27 (8.2m) trailers	- 5,100 cu. ft. (144.4 cu. m.)
8.	40 ft. and 27 ft. trailers	- 4,200 cu. ft. (118.9 cu. m.)
9.	26 ft. (7.9m) truck with 35 ft. (10.7m) trailer	- 3,400 cu. ft. (96.3 cu. m.)

Exhibit 2

WESTERN HIGHWAY INSTITUTE

333 PINE STREET, SAN FRANCISCO, CA. 94104

AREA CODE 415-986-1069

MODEL RULES AND REGULATIONS FOR THE UNIFORM AND SAFE OPERATION OF LONGER COMBINATIONS

(Multiple Trailer Combinations Operated Under Special Transportation Permit)

1. The attached model rules and regulations are intended to assist state, county, city and other governmental agencies to set up adequate uniform rules and regulations for the operation of longer combinations.

They are the result of many years of research and testing by Western Highway Institute and the work and experience of many states, toll road authorities and other public and private agencies as well as trucking companies which have been or are involved in operating longer combinations.

Extensive investigation into the performance characteristics of longer combinations has shown that, when operated with the proper equipment and driven by skilled professional drivers under certain controlled conditions, they are as safe as, and in many areas safer than, conventional trucks now being operated on all highways and streets. Accident frequency rates verify the superior safety characteristics of the longer combination when operated in accordance with good rules and regulations.

2. All equipment specified in the rules and regulations which may not be found on conventional truck combinations is readily available so that no company or individual will be prevented from operating longer combinations solely because their equipment does not meet specifications.

3. Detailed specifications on such equipment as brake tubing, lighting, emergency equipment and couplings which are found in many existing rules and regulations have been eliminated by the simple requirement of compliance with Parts 390-397 of the latest DOT Motor Carrier Safety Regulations. These regulations are far more thorough and extensive than found in any set of rules and regulations for longer combinations. They also provide strict regulation of drivers which strengthens the rules and regulations.

4. Although longer combinations have been operated safely in a few states on two lane roads, some regulatory agencies apparently desire to restrict their operation to interstate or four lane highways at least during the initial period of operation. When this is done, each company should be given a map or description of the routes on which it is authorized to operate and a copy of this should be placed in each longer combination for the drivers information and for regulatory purposes.

5. An established and aggressive safety program has been required because it is essential that the company, as well as the governmental agencies, monitors and regulates its operations. All on-highway accidents should be reported even though not

otherwise required so that a continuing analysis can be made of the safety characteristics of longer combinations.

6. The rules and regulations provide that the Permit Authority may restrict or prohibit operation during times or periods when traffic, weather, or other safety considerations make such operation unsafe or inadvisable. Longer combinations have demonstrated the ability to perform safely under adverse road and weather conditions. In some conditions, they are better than other trucks and passenger cars. About the only area of concern is traction which becomes a problem on steep, snowpacked, or icy grades when the truck or tractor has only one drive axle. Traction is considerably improved when two drive axles are used or when tire chains are used. Some permit authorities have established facilities where current road and weather information are available. These facilities also will have information on roads which may be closed to longer combinations and the periods during which the roads are closed. It should be the responsibility of the company and its drivers to fully utilize such services.

7. The rules and regulations do not attempt to regulate hill climbing or acceleration ability by weight to horsepower ratios, or by engine horsepower, because of the many variables involved which prevent assurance of the desired end result--which is a minimum speed on a grade. The Permit Authority may require whatever minimum grade speed it so desires although the model rules and regulations specify 20 mph. A weight to horsepower ratio of 350 to 1, or 400 to 1, is useful to check on the engine horsepower before a truck or a truck tractor is certified to be sure that enough horsepower is reasonably available to meet the 20 mph minimum specified speed on grades.

8. Some regulations require that the fast air transmission system apply the brakes on the rearmost axle first and then each brake successively toward the front. Other regulations say only that all brakes must be applied almost simultaneously. The application of brakes successively from rear to front was more important before the fast air transmission systems came into use because the delay in getting air to the rearmost axle allowed some overriding by the rear trailer. With the fast air system, all brakes apply almost simultaneously and this rear end stability problem has been corrected.

9. Only five of the most commonly used types of longer combinations are mentioned herein. Additional configurations may be included to meet the needs of different areas.

10. To insure the best operation of longer combinations, it is necessary that the Permit Authority strictly enforces the rules and regulations and revokes the permit of any company who abuses the privileges offered by the permit. This means that the company must be responsible for its drivers and the drivers must be responsible to the company. All three must fulfill their obligations to provide the safe efficient movement of goods on highways and streets. When this is done, the public will benefit in many ways.

Western Highway Institute welcomes all comments on these recommended rules and regulations which will assist in their improvement.

MODEL
RULES AND REGULATIONS

(Multiple Trailer Combinations Operated Under Special Transportation Permit)

Legal Authority for Operation: Multiple trailer combinations exceeding_____feet in length and/or_____ ____pounds gross combination weight may be operated in the _____in accordance with the following legal provisions:_____
_____
_____
_____
_____
_____

In accordance with the above, the_____has issued the following rules and regulations for the operation of such vehicles:

1. General: No multiple trailer combination can be operated unless it and its components have been approved by the_____and are covered by a valid Special Transportation Permit issued to the operating Company and no driver may operate such a combination unless he has been approved by the_____.

Any Special Transportation Permit may be revoked by the_____ for failure of the Company or any of its drivers to comply with any rule and regulation contained herein. In addition to the rules and regulations, all equipment operated, all drivers employed, and all operating procedures used must comply with the latest Motor Carrier Safety Regulations, Parts 390 - 397 of the U.S. Department of Transportation, Federal Highway Administration, except where the rules and regulations contain special conditions more stringent than or not in conflict with said Motor Carrier Safety Regulations.

Any Company approved to operate multiple trailer combinations under a Special Transportation Permit must provide the_____with such reports and data on accidents, operational costs, safety inspections, equipment, maintenance and any other item which he may require.

No Special Transportation Permit will be issued to any Company which does not have an established and aggressive safety program.

Multiple trailer combinations operating under a Special Transportation Permit shall travel only on those highways designated by the_____. The_____also may restrict or prohibit operation during times or periods when adverse conditions, traffic, weather or other safety considerations make such operation unsafe or inadvisable.

Transportation of Class A and B explosives, Class A poisons, and Class 1, 2 and 3 radioactive material as defined by the U.S. Department of Transportation as hazardous materials or any other material deemed to be unduly hazardous by the_____ is prohibited. This prohibition is not intended to include the transportation of gasoline fuel oil, or heating oil or other such petroleum products.

2. Equipment: In addition to Section I above, the following rules and regulations will apply:

a. Power All trucks and tractor trucks shall be powered to provide adequate acceleration ability and hill climbing ability under normal operating conditions, and to operate on level grades at speeds compatible with other traffic. The ability to maintain a minimum speed of 20 mph under normal operating conditions on any grade over which the combination is operated is required.

b. Traction All trucks and tractor trucks shall have adequate traction to maintain a minimum speed of 20 mph under normal operating conditions on any grade over which the combination is operated and to be able to resume a speed of 20 mph after stopping on any such grade and, except in extreme road or weather conditions, to negotiate at any speed all grades encountered.

c. Tires Conventional 12 ply tires are recommended. The use of the so-called low pressure or extra width tires are prohibited unless approved by the _____.

d. Fifth Wheel A heavy duty fifth wheel is required. All fifth wheels must be clean and lubricated with a light duty grease prior to each trip.

e. Pick-up Plates Pick-up plates must be of equal strength to the fifth wheel.

f. King Pin The king pin must be of a solid type and permanently fastened. Screw out or folding type king pins are prohibited.

g. Pintle Hook and Eye All hitch connections must be of a no-slack type, preferably air actuated ram. Air actuated hitches which are isolated from the primary air transmission system are recommended.

h. Drawbar The drawbar length should be the practical minimum consistent with the clearances required between trailers for turning and backing maneuvers.

i. Axles Axles must be those designed for the width of the body.

j. Brakes All braking systems must comply with state and federal requirements. In addition, fast air transmission and release valves must be provided on all trailer, semitrailer and converter dolly axles. A brake force limiting valve, sometimes called a "slippery road" valve may be provided on the steering axle. Indiscriminate use of engine retarder brakes is prohibited.

k. Mud Flaps or Splash Guards Anti-sail type mud flaps are required.

3. Type of Combinations: The following multiple trailer combinations, when approved by _____, may be operated under a Special Transportation Permit. All multiple trailer combinations listed below must have at least six axles and not more than nine axles and shall consist of not more than three cargo units.

a. A tractor truck, semitrailer and two trailers, which have an overall combination length not to exceed 98 feet. A semitrailer used with a converter dolly is considered to be a trailer. Semitrailers and trailers must be approximately equal length.

b. A truck and two trailers which have an overall combination length not to exceed 95 feet. The trailers must be of approximately equal length.

c. A tractor truck, semitrailer and trailer which have an overall combination length not to exceed 105 feet. A semitrailer used with a converter dolly is considered to be a trailer. Semitrailers and trailers must be of approximately the same length.

d. A tractor truck, semitrailer and trailer, one of which cannot exceed 45 feet and the other which cannot exceed 29 feet, nor be less than 26 feet, and which have an overall combination length not to exceed 90 feet. A semitrailer used with a converter dolly is considered to be a trailer. The shorter trailer must always be operated as the rear trailer.

e. An autotransporter combination consisting of a truck and two stinger steered semitrailers not to exceed 105 feet in overall combination length. The two semitrailers must be of approximately equal length.

4. Drivers:

a. A driver must have had at least eight years of experience driving truck trailer combinations, five years of which must have been in driving multiple trailer combinations such as doubles or triples.

b. The driver must have had no traffic citations during the past three years while driving a truck.

c. The driver must fully comply with the driver's requirements set forth in the Motor Carrier Safety Regulations of the U.S. Department of Transportation.

d. The driver must have had special instruction and training in the operation of any multiple trailer combination listed under Section 3 prior to operating any such combination on a highway.

e. The driver must be under the control and supervision of the Company holding the Special Transportation Permit.

f. Any wilful violation of the requirements of this section may result in revocation of the driver's certificate or the Company's Special Transportation Permit.

5. Speed: The maximum speed for any multiple trailer combination under a Special Transportation Permit shall not exceed 50 miles per hour.

6. Stability: All multiple trailer combinations must be stable at all times during normal braking and normal operation. A multiple trailer combination when traveling on a level, smooth, paved surface must follow in the path of the towing vehicle without

shifting or swerving more than three inches to either side when the towing vehicle is moving in a straight line.

7. Weight: The total weight on any single axle shall not exceed 20,000 pounds. The total weight on any tandem axle shall not exceed 34,000 pounds. The total weight on any group of two or more consecutive axles shall not exceed the amount shown in the accompanying weight table. Gross combination weight shall not exceed 105,500 pounds.

8. Load Sequence: In no case shall any trailer or semitrailer be placed ahead of another trailer or semitrailer which carries an appreciably heavier load. The heaviest trailer or semitrailer should be placed in front and the lightest at the rear. Except in the combination described in Section 3d, a empty trailer or semitrailer must not precede a loaded trailer or semitrailer.

9. Operational Procedures: A minimum distance of _____ feet shall be maintained between a multiple trailer combination and other vehicles except when overtaking and passing.

Except when passing another vehicle traveling in the same direction, or when emergency conditions exist, a multiple trailer combination must remain at all times in the right hand outside lane.

In the event a multiple trailer combination is disabled for any reason other than an accident, it should be parked as far off the traveled way as possible.

10. Accidents: Notwithstanding other state and federal requirements for reporting motor vehicle accidents, all reportable accidents involving a multiple trailer combination operated under a special transportation permit must be reported to the Permit Authority within ten days of the date of the accident.

11. Insurance: Every multiple trailer combination operated under a special transportation permit shall be covered by insurance of not less than $25,000/$100,000 public liability and $10,000 property damage.

Analyses of fatality occurrences relating to the weight of vehicles have not been conclusive but indicate that the effect of the weight of a vehicle may level off at around 60,000 pounds (27.2t).

It is important to note that all of the considerations and relationships described relate to vehicles that are currently on the road in common use. Large and heavy vehicle configurations that are now being tested or are in limited use often have substantially better safety records than existing vehicles. However, the limited use situation may not properly reflect their behavior under expanded use, particularly since their drivers, at present, tend to be especially selected and paid at premium rates.

In addition to other considerations, greater efficiency in truck transportation may help to reduce accidents. Theoretically, trucks carrying greater payloads would move a given quantity of freight in less trips, resulting in reduced truck exposure in the traffic stream which should generate a reduction in the number of accidents.

Intermodal concerns relate to truck-rail competition. The question is whether permitting truck size and weight increases will result in capture of more of the rail market. While this question is pertinent at this time in that decisions presently need to be made relative to possible government support of railroads, it does not appear to be a question that is particularly relevant to this research project.

With respect to the competitive situation, there appears to be only one sound basis on which to base a decision not to take every opportunity

NATIONAL TRUCK EXPOSURE SYMPOSIUM

QUESTIONS AND ANSWERS

Monday, April 9, 1979

Session I

1. James O'Day - "General Impressions of the State of the Art"

Comment: Dr. Brenner

"A mile of travel is not a mile of travel for all types of vehicles." Fire truck exposure is different from passenger car exposure.

Question: Marty Reiss

We are groping in the dark with low response rates - there is involvement by different agencies and contractors - and there are difficulties in imposing a uniform scheme . . .

With 50 automatic counting sites

- What exactly is being counted? Tires?

- What is being done in Michigan and how useful might that be with respect to trucks?

Response: James O'Day

The simplest method of counting is the use of a preumatic hose and hand counter, which counts the number of vehicle axles.

Ten years ago, single magnetic loop counters were installed in all 4 lanes of the highway in both directions. Through an automatic Watts line system, counts are dumped into the State Highway Department Computer System every hour where they are stored.

Two procedures are used to adjust miscounts which result from time lapses due to difficulties in getting through to the computer. These procedures involve the use of:

1. multiples by the number of minutes missed (in cases of short lapses of time); and

2. alogorythms (in cases of longer lapses of time)

Recently installed double magnetic loops count the number of vehicles and provide information on the length of vehicles, speed, and time of vehicles as well as differentiating between trucks and cars.

Magnetic loops count number of vehicles while pneumatic hoses and handcounters count number of axles.

2. Dr. Berger - Why Exposure Data?

Comment: Dr. Brenner

Perhaps there are uses for exposure data beyond safety.

- Do we have the resources to invest in collecting exposure data?
- Is this an appropriate use of money?
- Can expenditures be justified simply on the basis of safety?

Dr. Berger points out that there are other uses for exposure data, such as in logistics, routing or hazardous materials, etc., and that a generalized exposure model may lead to a broadening of the issue beyond safety.

It is difficult to devise a uniform scheme for amassing and utilizing information.

Question: Marty Reiss

Can we really afford the collection of exposure data? Do we need in-depth continuing samples or can we survive with 5 year census type surveys?

Response: Dr. Berger

Congress is committee to NHTSA's collection of accident rate data. If the context for exposure data were broadened and made salable from a broader perspective it would be of greater interest to Congress. There is a "selling job" associated with that program.

Similar programs have been funded in the past ($17 million) and it would not be impossible to gain support now but selling must begin with the constituency agencies. Costs for developing a reasonable sampling system would not be extravagant.

Dr. Waller:

Can we afford not to collect exposure data?

Dr. Berger:

The case must be made that having those data will be cost effective. This case has not been made in the past.

Charles Brady:

Congress has appropriated money for a cost allocation study. How can this be done without exposure data?

Dr. Berger:

The cost allocation study is a one-time study. We are talking about an on-going data collection system.

Charles Brady:

Initiation costs are the largest item.

Dr. Berger:

The time-frame in which you think the system will run must be considered in determining how an on-going exposure data system will be developed. Such a system is not necessarily compatible with Congress' cost allocation study which is intended to determine the appropriate allocation of costs of constructing highways per classification of vehicles.

Dr. Brenner:

Are there indications that Congress will give agencies more money to set up comprehensive exposure data systems?

Dr. Berger:

Yes, under the right circumstances. Keep in mind multiple uses of exposure data. Are these multiple uses being addressed by the system? States are pressed to certify that their vehicles comply with the speed limit. Perhaps what is needed is a programmatic approach which will combine federal and state needs in collecting exposure data on an ongoing basis.

Session II

1. Arthur Wolfe: A National Exposure Data System

Dr. Waller:

What do you mean by trucks?

Dr. Wolfe:

There are three different sources of definitions of trucks:

a. Cargo vehicles: commercial trucks;

b. Truck driver: Census Bureau Classification by occupation which does not include route and delivery drivers; and

c. NHTSA accident figures: all trucks including pick-ups and vans.

Dr. Eberhard:

Do you consider a surveying of drivers when they are being relicensed?

Arthur Wolfe:

One of the drawbacks of that approach is that only one-half of the states require in-person renewal of driver's licenses. This would not provide a sample representing the nation.

M. Freitas:

OMB will not approve a police pulling drivers off of the road for survey purposes. OMB does not perceive this as "voluntary."

A. Wolfe:

A recent Supreme Court ruling has outlawed discretionary sample stops by police, although if the sample were truly random it could still be considered legal.

Phyllis Young:

Does (Wolfe's) study document of shortcomings of various systems in terms of unappropriateness for NAS?

A. Wolfe:

No. The idea of NEDS was to complement NAS by collecting exposure for use by NAS. They took NAS as it was designed.

Tom May:

Is cost or confidentiality the problem associated with license plate surveys? What is the latest?

A. Wolfe:

There has been a decline in this practice. California conducted a survey on the Freeways between Sacramento and the Bay Area. Toronto is experimenting.

There have been hundreds of origin-destination studies for local transportation studies in general.

Dr. Brenner:

Techniques for photographing license plates were developed at UCLA in the late 1950s. Followbacks were used. Individual vehicle records were easily accessible.

Perhaps the idea of computer technology combined with license plate methodologies should be reexamined.

A. Wolfe:

It is alright to go into records, but not sanquine about contacting drivers.

Dr. Brenner:

It is possible to use computer data without violating privacy of individuals.

National Seat Belt Survey conducted by Opinion Research utilized state license files to obtain information on types of vehicles. Approximately 20% of the recorded license plate numbers could not be located in the computer.

2. Gerry Vallette - <u>On the Need for Truck Exposure Data for Accident Analysis</u>

Vernon Roberts:

Does BioTechnology have data for both cars and trucks in California?

Marty Reiss:

It only exists for 20 sites in California. It was not possible to collect data for both everywhere because of the associated cost.

Session III

1. Carmen Campbell - U.S. Truck Inventory and Use Survey

Dr. Brenner:

Be thinking about:

1. Issue
2. Complete Statistical study conducted by Bureau of Census
3. FHWA's survey
4. NEDS and NAS
5. NHTSA

Is it possible to relate these various studies in some fashion, even conceptually? A number of different data bases are being generated at different levels, can they be combined?

2. H.C. Joksch (Reidy) - Detailed Measures of Exposure

Dr. Brenner:

Census started out with a definition of "universe" and then defined a particular population from the universe and then defined samples selected from the population. This is classical statistical technology. The plan was developed so that statistical inferences could be drawn

What is the universe or its pupulation of interests in this business of quantifying exposure:

miles estimates?

vehicles estimates?

characteristics of operators?

accident group?

driving population?

Are we defining an accident population of total population and then trying to compare accident and non-accident populations?

3. John Reith - <u>The Truck Operator's View of Exposure Data</u>

Dr. Brenner:

I'm impressed with the National Traffic Safety contest and the fact that truckers are angry at being misclassified. Trucking industry has 46 years of experience in stratifying types of vehicles. They are stratifying their risks.

To what extent canour Government agencies begin to bring this kind of experience into developing a model?

Mike Freitas:

The Government has not taken full advantage of ATA data. The BioTechnology study was concerned with stratification in terms of driver age and experience. They tried to get clues like this in that study. They were concerned about the type of operations using singles and doubles. When you compare the two you might be comparing "apples and oranges" whereby instead of comparing vehicles you might be comparing companies. It is important to look at the types of services utilizing the singles and doubles.

Dr. Brenner:

Truckers do not differentiate between single and double bottoms.

Cerelle:

In the past, lack of cooperation within the Department and in the field has caused problems. I welcome suggestions from ATA.

Dr. Brenner:

The trucking industry and Government agencies must cooperate.

Discussion

Conrad Cooke to Mr. Reith:

What is the sensitivity of accident/fatality rates to size of the operator--the trucking company itself?

Reith:

There are no data relating the size of the fleet to accident rates. It is more dependent on the size of a highway than size of the vehicle fleet. Differences which are based on operations are more significant.

Conrad Cooke:

Small fleets tend to operate in small communities. What is the best set of independent variables?

Reith:

Both small and larger fleets operate in all contexts of the industry - intercity, between cities, or nationwide. You can't generalize on the basis of fleet size.

Tom Herzog:

How can you differentiate between whether it is the experience of drivers or the type of vehicle which influence accident rates?

Mike Frietas:

We have accident rates for doubles and singles on sites for

1. age groupings
2. experience groupings as professional drivers
3. experience as the driver of a particular rig

Dr. Brenner:

This can be answered using multiple correlation methods if data are available.

"Following-too-closely" as a cause of crashes is a convenient way of blaming drivers. What would be an appropriate measure of exposure as it relates to "following-too-closely?"

How can the risk associated with "following-too-closely" or with "splash" be quantified?

Mr. Rudy:

"Following-too-closely" is multi-dimensional. It has been suggested to NHTSA to determine quantitatively what "following-too-closely" is by using aerial photographs to record the:

1. speed of pairs of vehicles
2. closing speed of both vehicles
3. gap and closing speeds

and look at accident rates for various combinations of the three factors.

Not sure how to measure spray within a physical model. NEDS could not collect this data. A site specific method is needed.

A surrogate measure might be the number of times vehicles have passed trucks on wet roads for trends.

Dr. Brenner:

Assuming that "following-too-closely" involves the length of space between vehicles.

If we are concerned with following too closely, how do we make sure this is not over represented?

Fred Hanscomb:

My paper provides rear-end measures.

* * * * *

(BREAK)

1. Robert Ferguson - ICC's Data Collection Activities for Commercial Motor Carriers

Dr. Brenner:

Is it possible to take ICC's data base and integrate it with other data bases, or is it necessary to wait for standardization of definitions?

Marty Reiss:

Are hard copy data available to the public. When you look at computer tapes can you get down to an individual city and an individual carrier?

Mr. Ferguson:

All ICC information is open to the public under the Freedom of Information Act. The ICC reference library is open to the public as well.

Dr. Brenner:

Origin and destination information from one city to the next. FHWA has road information from city to city and States have accident data. Is it possible, if ICC has distribution of trip time between two points, to combine the three sets of data?

Mr.Ferguson:

I-27 carriers - three cost regions all involved in a cost study for that particular year only. Every carrier who files for operation rights must file a routing map with the ICC for permanent authority to operate in that area. This information only involves a subset of total sample. ICC has a contract out to try to automate operating rights.

Dr. Pat Waller:

More information on independent truckers in ICC files? State accident files do not identify the commodity carried. How can ICC data be combined with safety information collected by States?

Transportation System Center Report tells the commodities carried by trucker, point of origina, transfer, destination and amount collected only.

Mr. Ferguson:

We do not collect this information. Schedule M provides some information about commodity carrier for Class I and Class II carriers.

Bulk carriers and carriers of farm commodities are ICC exempt, but the States should know about them. Many carriers hire independent truckers, so that, if an independent trucker crashes it is not indicated.

Dr. Brenner:

Data collected on accidents do not track back to ICC data files. Perhaps we need to examine linkage with other files.

Can we relate accident information to broader based information that ICC has? I'm not sure that we can.

Dr. Waller:

How could you get it out of State data? Many companies hire indepedent truckers - States won't identify carriers.

Dr. Brenner:

Data we are now collecting does not fit this bill.

Jean Kidwell:

Exempt carriers report accident data to the Bureau of Motor Carrier Safety. Accident data for Class I and II carriers are reported to BMCS, mileage is reported to the ICC.

Mr. Herzog:

What percentage of accidents are reported to BMCS; there is no double checking.

Jean Kidwell:

Double checking is on an individual basis only.

Dr. Brenner:

There are apparently incomplete accident data files.

2. Mike Freitas - (Solomon) - Why Do we Need Special Commercial Vehicle Exposure Methods?

Mr. Reith:

Problem with Mike Freitas' concept of "ton miles" - When speaking of "ton miles" in context of your statement, speaking of maximum gross weight by axle weight and not state maximums. It is therefore a theoretical discussion.

In practice, I'm not sure that the concept of ton miles is suitable. (Concept of ton miles is not a very good one.)

Mike Freitas:

Ton-miles favors larger trucks. Here we use average cargo weight rather than legal weight. In general freight, you get a heavier load when you use doubles and triples because cargo is so light. Ton miles is a better measure when you want to determine how safety will be effected by changing loads.

As the size and weight are increased, cargo is shipped in fewer trucks. As the driver of a passenger vehicle, you would want a safe truck in terms of VMT, whereas a policymaker sees ton-mile as safer.

Mr. Reith:

Substantially more data than are currently available are needed to do that type of comparison.

Dr. Brenner:

Select the proper statistical lease to extract the data you need. All of us are stakeholders in transportation - Office of Technology Assessment has developed concept of stakeholders.

Mr. Cook:

What is the Concept of using involvement rate per ton mile.

Is there any difference in the cost of an accident involving varying severity?

Mike Freitas:

Anytime you have to know the involvement rate by any measure of exposure, you also have to have a measure of the severity per accident or the severity rate. You have to look at the total question: how many people and how much property.

Dr. Brenner:

Should we design a statistical system and then design questions or should we define the questions first?

Howard Anderson:

BMSC accident file covers everything. 3,000 fatalities were reporte last year. FARS reported 4,100. Most regulated carriers are good in reporting fatalities - less than 10% went unreported). Most independent, private and exempt carriers do not report at all.

Marty Reiss:

BMCS has some accident data. ICC collects interesting statistics on carriers. States collect data (FHWA is compiling some of this information).

What are the most relevent variables? In our study, we arbitrarily assigned variables.

Throw out measures that have not been mentioned? Accident and exposure data.

General Discussion

Marty Reiss:

Different groups are collecting interesting types of information.

Each group has its own interests it would like to see included in a common data base. This becomes very complex in terms of specific items that could be included.

Have to have descriptions on vehicles and drivers.

Many accidents happen on exits and entrances to highways, not only on highways themselves.

Some measures of interest not mentioned thus far include; both accident and exposure data for commercial trucks . . .

Session IV
Tuesday, April 10, 1979

Fred Hanscomb's Paper

Marty Reiss:

I believe if you use this technique at places where there are metal loops already in place you avoid having to stop traffic for installation.

Arthur Wolfe:

Did you use one frame for each time? Did you just count the particular vehicle which triggered the camera?

Marty Reiss:

Basically, yes. We tried to get the data analyst to vary it across the lanes. We only had 3,000 frames to represent a week, so there were some limitations. Generally, we counted the vehicle which could be clearly seen. You're counting axles, so you have to know the average number of vehicles for the site.

Arthur Wolfe:

Do you ever try to get the license plates?

Marty Reiss:

No. We would have had to be closer for that. We placed cameras on top of hospitals, restaurants, etc. We consider using strobe lights, but this would have created a safety hazard. We collected data at six different roadway types. We didn't use field employees because it would be expensive to supervise them. That's why we used film and inexpensive cameras. I would not recommend using tapes because you have to stop traffic to install them. We used the TES* at 14 out of 78 sites and gathered a lot of microdetails. We observed one actual accident, a pickup crashing into a truck. The TES supplied the exact speed of the truck and the vehicle following it. We determined that the truck was going unusually slow.

* FHWA - Traffic Evaluator System

Mr. Hanscomb:

We had to modify our software to accommodate the truck because it was moving so slowly. There are factors other than size and weight which influence operational data. We need more knowledge about exposure data.

Tom May:

You have collected some excellent unbiased speed data. It would be interesting to compare these situations with the total traffic flow. The FHWA and the NHTSA might do this.

Mike Freitas:

FHWA has pre-1973 data.

Mr. May:

That's ancient history.

Mr. Hanscomb:

Our data was gathered at six different grade conditions and at various curves and lanes, so it may not be representative.

Marty Reiss:

We spent a tremendous amount of money on the research, planning and implementation for this study. The study only only lasted for a short period of time. Having spent all this money on planning and start up, it would make sense to keep such projects running for four or five years. It's hard to convince the government to fund this.

Dr. Richard Ibson:

Can your data be massaged to yield motorcycle data?

Hanscomb:

Yes. Motorcycles, because they are lightweight, are less prone to trip the switches. Our data can be massaged in a variety of ways. We are somewhat constrained because we are looking at axles. However, we were able to pick out school buses.

Mr. Reiss:

In selecting our sites, we focused on interstates and rural roads. Our sample was stratified by geographic levels and by accident rate. We tried to randomly sample high, medium and low traffic accident sites. This is not ideal for collecting cycle data.

Kenneth Shuey:

Did you try to link cameras up with automatic recorders already in place in the states? This would have limited you to the 100 such sites in Iowa.

Mr. Reiss:

The sites had to be uniform across state lines. This might be hard to achieve using the automatic sites.

Mr. Hanscomb:

The counters don't provide as sensitive configuration data.

Dr. Lloyd Philipson's Paper

Dr. Waller:

Why were crashes involving two commercial vehicles eliminated in the induced exposure?

Philipson:

Since we were sampling accidents where the truck was the non-responsible party, we didn't want to confuse who that party was.

Dr. Waller:

However, since tractor-trailors are more likely to collide with another tractor-trailer than with cars, this introduces some bias into this data.

Philipson:

You might be right.

Mr. Freitas:

Do you know anything about California's automatic vehicle classification system?

Philipson:

I don't know anything about that. It might involve an application of the TES thought process. Using a photographic procedure, you can track down vehicles and get weights and other information, but you can only do this with a small sample.

Reiss:

In your final report, I noticed some similarities in data across states.

Philipson:

Unfortunately, those are only accident frequencies. These data tend to be relatively good.

Thurm Sherard:

Remember, Michigan's double bottom tankers are illegal in 49 states. California was extrapolating this data. That's dangerous. You never put a full tanker behind a half full or empty tanker. The load sequence must be that the heavier load is in the front.

Wolfe:

Michigan also permits higher maximum weights.

Freitas:

HSRA recommended that certain modividations to double bottoms makes them as safe as trucks with pups. By banning double tankers you create an unsafe condition by doubling the number of tankers on the road. The question you want to ask is: "What's the safest way of getting gasoline to the stations?"

Reiss:

How do you check the validity of telephone surveys?

Wolfe:

We didn't validate results of our survey. We did ask the interviewee the source of his data. For a continuing national survey, you might want to consider using personal visitation.

Wolfe:

Does the FHWA give the states any guidance in selecting the location of their stations?

Kent:

Yes. We recommend an optimum number of stations depending on the number of miles covered. We have no control over whether they accept our recommendations or not..

Staley:

How about utility trucks? Are they counted as service trucks?

Kent:

Service trucks are taken out of the empty/loaded survey. They are too heavy to be called empty and too light to be called loaded. The carrying of payload is the distinguishing characteristic for this survey.

Staley:

Then how would you characterize a repair truck carrying TV's back to the shop?

Kent:

This would be considered payload.

May:

What about the effect of trucks on bridges?

Kent:

Case Western is working on this currently. They are testing it in Ohio and on I-95 in Virginia.

Freitas:

I think they are testing it near Dumfries, Virginia.

Kent:

In Florida, the weighing in motion system, twelve sites are used, the trailer floats around the state. The weight platform can be carried from plact to place.

Reiss:

Is this survey taken every year?

Kent:

No, biannually.

Kenneth Shuey:

In Iowa, we've been trying to accommodate the fall and spring crops.

Frietas:

What is the situation regarding federal aid to the states? Can they get aid to buy scales which aren't being used for law enforcement purposes? This should be looked into.

Kent:

Bumper to Bumper length is recorded automatically. The classification is in the computer system.

Sherard:

Can you estimate your accuracy on this?

Kent:

Plus or minus 7%. We use a triangular plate on the treadle to get away from rocking. The heavier the truck, the tighter these error percentages.

Philipson:

Does the data collection effort vary from state to state?

Kent:

Iowa as always been the most cooperative state, although right now Florida weighs more trucks than Iowa does. I go out and work with the states. The federal government

has to convince the states that they need this data also. The states don't realize that they are using the data, when Congressmen can't get the data from them, we supply it. The states always say they don't have the money to weigh trucks. Federal aid can be obtained for scales used on the interstates.

Howard Anderson:

I believe federal money is available for weighing in activities other than on interstates. For demonstration profects, the federal government will pay for training and inspection activities in two or three states.

Kent:

We have body type codes and vehicle type codes. The body type doesn't yield data about commodity carried.

Richard Bodle's Paper

Reiss:

I'm interested in how you monitor performance? Would you go back to the truck weight study to provide data for this?

Bodle:

This data is biased. We prefer to collect classification data independently of this.

Session VIII

Patricia Waller's Paper

Wolfe:

The annual data you collect from vehicle inspections, couldn't you also get that when motorists register their vehicles?

Waller:

It was too difficult for the states to provide it. It would mean creating more spaces in their computer systems.

Freitas:

Don't service stations which inspect vehicles keep odometer records?

Waller:

That's what we used. We collected their forms. It is an easy, ongoing data collection effort. These forms are kept at the service stations for one year. The states only get summary data. The problem with collecting the data nationally is that vehicle inspections are not conducted uniformly at the same time throughout the year.

Charles Stoke:

Virginia is another state where you might be able to collect vehicle miles travelled using vehicle inspections. These inspections are done every six months and the odometer readings are kept for three years. The problem in Virginia is that the license plates travel with the person, so that when someone gets a new car, you're going to have a drastic mileage change perhaps in the wrong direction, going with the same license number.

Mela:

North Carolia writes the odometer reading on the vehicle inspection sticker, but Virginia doesn't do this.

John Brennan:

More and more government agencies are asking for more and more data. It's different when you ask a company with a fleet of 100 trucks for odometer readings than when you ask a motorist with one vehicle. I think we need an appreciation of how much research a clerk has to do to collect this data and what it would cost.

Mela:

In this particular case, though, the data has already been recorded by the person conducting the vehicle inspection.

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Wednesday, April 11, 1979

Session IX

David Andersen - Forcasting Motor Carrier Demand and Equipment

Dr. Brenner:

Dr. Berger presented a matrix of uses of exposure data - issue:

(1) are we investing enough resources in collecting exposure data?

(2) problem of cross-coding between various data banks

Both issues have emerged from Dr. Andersen's talk.

(1) How sensitive is Andersen's model to the quality of exposure data - Figure of 5% represents a lot of money

(2) Why shouldn't private industry kick-in money to collect exposure data? We don't want the Feds to spend all the money.

(3) Is FHWA concerned with empty back haul?

(4) Is NHTSA as concerned with safety of heavily loaded trucks as it is with light loads?

(5) Are we concerned with safety as we are with economics?

Mike Freitas:

Why did the "Trucks in Use Table" indicate more trucks in use two years after the model year?

Mr. Andersen:

(1) Concept of model year for trucks is not the same as for cars.

(2) Trucks may be deregistered and then brought back on the road.

Mr. Whitney:

(Will contact Mrs. Baker about Brakes)
How does DRI differentiate between interstate and intrastate data, and private and exempt.

Mr. Andersen:

DRI has better traffic information on exempt than for private UMT.

There are many private studies being done but there's no assurance that the information will be shared.

Marty Reiss:

Can your data (types of analysis) be related to safety and exposure at state-regional and local levels?

Mr. Andersen:

We haven't done much disaggregation of data according to vehicle classification because of lack of interest. Energy related analysis does involve some regional evaluation but none in relation to exposure data.

Thurm Sherard - More Productive Trucks Can Reduce Exposure

Dr. Brenner:

We know there are problems associated with cab size.

Increasing length of boxes is wrong approach.

Problem: State legislatures and opponents of the trucking industry oppose multiple trailer units but support increasing the lengths of units since that's the only way to obtain the "cube."

Decreasing the driver cab has been the only way to increase the amount of payload at the cost of the safety factor - It is not a good approach.

Dr. Waller:

If longer rigs truly are safer, why restrict operation to better drivers, why not place less careful drivers on these rigs?

Mr. Sherard:

Triples drivers can drive anything. Trying to upgrade overall. They also drive the rigs in the order in which the rigs come up.

Dr. Waller:

Question not answered.

Dr. Brenner:

Maybe the effect of longer rigs is a result of better drivers.

Dr. Sherard:

With triples, you can carry more weight with less impact on the pavement. There is greater breaking ability because you break axle loads not gross weight. Energy load can be dissipated much faster.

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Sumner Chansky:

Have you considered that triples only operate on freeways which are inherently much safer? Are you recommending the use of triples on two lane roads?

Mr. Sherard:

Recommendations are on four-lane and two-lane highways.

Triples are operating safely in several states, some of which are allowed on all roads.

Nevada: triples can operate on any road with no restrictions. There have not been enough accidents, over eleven years, to develop an accident rate.

Utah: allows some operation on double highways.

Oregon: Triples are considerably more safe.

There is no scientific explanation as to why triples are more safe.

Mr. Brennan:

(ATA) problem: Senior drivers drive triples because Union regulations impact on who drives larger rigs at higher pay rate.

Gerry Vallette:

Accident study in Nevada recorded no triples accidents in a year and a half.

Dr. Brenner:

Do we have the capability in present systems for collecting exposure data to measure various effects we are postualting?

Have we counted crashes that might have been induced by passing vehicles? Maybe triples are safer vis a vix stability of breaking but how about passing?

Gerry Vallette:

Police have labeled some accidents as "truck-induced" though in actuality they are not. We will do a small analysis.

Dr. Brenner:

Where will the money come from to do more systematic evaluations?

Mr. Sherard:

An extra 6" on two-lane highway translates into an increase of 1½" on passing distance.

An increase in the trucks width is not observed by the passenger vehicles which they pass (observed as increased height).

Pallets are just part of the problem. Spray from triples vehicles exerts 20% less than semi's tractor trailers.

Dr. Brenner: We've attempted to correlate different types of data, but it's difficult. Consider the following:

Are we collecting enough exposure data?
Are the data adequate for our needs?
Are we doing a proper collection and analysis of explosure data?
Do we know today what the ideal exposure system ought to be in terms of needs and technologies in order to define the perfect system?

Ms. Young: FHWA has identified safety related data needs in general.

We should capitalize on what is available already. There are variations on a theme with respect to specific needs. We may come up with improved ways of using existing data. Perhaps we should look at other sources and miximize the existing data. There needs to be a cooperative effort in developing guidelines.

Dr. Brenner: Could we design an imperfect exposure model?

Dr. Cerrelli: We have a potential one.

Dr. Waller: Share information on the Tachograph?

Thurm Sherard: Teamsters oppose the Tachograph because it records miles, speeds, RPMs, how long they stop for lunch, etc. Some companies require tachographs and use them to monitor drivers in order to penalize those who violate company requirements. 32 channels monitor everything.

We are looking at tachographs as a research tool; not as a means for evaluating drivers.

Dr. Brenner: The issue of using electronic equipment to monitor drivers has been stopped by Congress.

Dr. Waller: Laws of physics imply that dangers associated with larger trucks are greater.

Dealing with two different issues when talking about trucks and passenger cars. Present the issue to the Hill in the right way and the Hill can be sold.

Dr. Brenner: I disagree with the Hill's action.

Perry Kent: The Automatic Vehicle ID System works in California but it violates the privacy act.

Dr. Brenner: We have the technology and hardware associated with upgrading exposure data, so what is missing with respect to generating better data? Why aren't we doing more?

Marty Reiss: The automatic vehicle ID systems require road side detection equipment and capabilities to read the information. It's a costly system that can't be tied together and used for just one purpose.

Perry Kent: The cost is $200 per vehicle. 155 characters could be transponded . . .

Dr. Brenner: Another issue regarding highway safety requirements - We don't need to measure very individual truck.

What type of massive statistical system would begin to deliver significant data?
What kind of statistical sample do we need? Are we looking at a massive amount of sampling?

We don't really need 100% exposure measuring systems.

Mr. Mela: There are always unanswerable questions, therefore, you have to prioritize questions to be asked.

Dr. Brenner: Should we put as much money into the collection of exposure data as in the collection of accident data?

Mr. Mela: For planning and productivity, you need more exposure data for commercial vehicles; otherwise, more for accident data.

Dr. Brenner: (ATA) Once you have all the data, you must be careful not to misuse it. Have to be sure of what the data do not say as well as what they say.

Concluding Comments

Mike Freitas: We have not solved the problem here, perhaps we haven't defined the problem.

My personal believe is that more exposure data are needed, but the idea of developing a national exposure data system is frightening. The BioTechnology study cost $7000,000 - $800,000 --a drop in the bucket for developing an annual system.

Be careful in talking about an all encompassing device. It is important to emphasize that too much is done without exposure data in making comparisons related to trucks. Watch out for biases.

Assess what is needed--there are biases in the available data--and express those things specifically.

We have established that there is not enough.

Mr. Mela: In the case of trucks, you must consider truck productivity in terms of ton miles. Summarize different purposes, it is clear that there are a variety of purposes and measures that can be used:

1. Accident research and analysis;

2. Economic policy measures.

Do we need a national system or do we need data on a one-shot basis? There is a problem of priorities. A large portion of exposure data are collected for other purposes. NHTSA must work together with FHWA.

Mr. Andersen: I'm not convinced that an arrangement can't be made for deriving a good statistical sample for VMT if the data are obtained directly from the carriers. We inspect them every year. It is as accurate as the NASS. Congress is getting information that trucks kill three times as many people as cars, but they don't have exposure data. This would not cost millions of dollars as Mike said.

I disagree that we can totally ignore exposure data.

Mike Freitas: There is a need for better national commercial vehicle exposure data that will serve multiple uses.

My point is that a data base doulw never serve <u>all</u> purposes.

Dr. Brenner: I wasn't implying an all encompassing system. A model exposure system could be a 1% sample.

Have we ever systematically defined the kinds of questions we would seek to answer using exposure data?

Can multiple sources be coupled? Do we know how to do this?

Lloyd Philipson: There are two systems in place - ADT*and TWD**. Has DOT studied the potential for improving these systems?

Frank Raymond: There is a two year project to be completed this summer which is looking at the number of counts, location, duration, to get good ADT figures to come up with VMT.

This will result in some good answers. We may not need all of the continuous counters that we have now.

The Highway Performance Monitoring System can sample sections by State.

* Average Daily Traffic

** Truck Weight Data

Marty Reiss: Does this study apply to trucks?

Frank Raymond: No, it is addressed specifically to total counts. There is some vehicle classification being done in States.

Art Wolfe: Using some reliable random samples for ADP data. Maybe this could be a good vehicle for expansion.

Asking states to get good random samples of roadways.

Frank Raymond: State programs are in place, however, may not be reliable. There are many different definitions of exposure. We need to look at present data collections.

Marty Reiss: We need several things at different levels.

The conference was interesting in seeing the different data bases that exist.

. . . look at the accuracy of exposure data collected in different states.

Needs are continuously changing. We need both national and specific studies as well as a means for tying them together.

I don't think a single existing source can provide an adequate data base for national exposure measures.

What is promising as an outcome of this meeting is that groups from different backgrounds and expertise are interested in the exposure issue. I'm not sure how to harness all of the talent. DOT, FHWA and NHTSA should think about what has been discussed at this symposium and develop some long term planning.

END OF SESSION

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APPENDIX

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8	Explanation of Reimbursement Policy
9	Reimbursement Form
10	Hotel Registration Form
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12, 12-1	Work Plan and Time Schedule
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13	Proposed Facility Arrangement
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Form 1

TISA

THE INSTITUTE FOR SAFETY ANALYSIS
6400 Goldsboro Road
Washington, D.C. 20034
(301) 229-8789

Dear Colleague:

As a function of your work in the area of commercial trucks and/or exposure estimation your name has been recommended to me as a potential presenter of a technical paper or potential attendee and participant in a technical work group.

At this point in time please complete this form and mail it back to TISA:

☐ Yes, I would be interested in attending the symposium if it were held in Washington, D.C. roughly in the time period of April, 1979.

☐ Yes, and in addition to attending I would be willing to prepare a technical paper for presentation (20 minutes/half hour) and publication in the symposium proceedings.

My topic might be briefly summarized as follows:

_____

_____

_____

_____

I would suggest that you contact the following individual in relation to participation at the symposium:

Name: _____

Address: _____

_____

Phone: ( ) _____

PLEASE FOLD, STAPLE, STAMP, AND MAIL AS SOON AS POSSIBLE

SEE OTHER SIDE

Thanks!
Marty Reitz

TISA

THE INSTITUTE FOR SAFETY ANALYSIS
6400 Goldsboro Road
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NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATION

The Institute for Safety Analysis was awarded a contract (DOT-HS-8-02046) from the U.S. Department of Transportation to plan, schedule and coordinate all activities to permit the conduct of a successful symposium. The 3-day symposium jointly sponsored by NHTSA and FHWA is to be held in Washington, D.C. in the second quarter of 1979.

The scope of the symposium will include:

- the need for exposure measurement as an element of; safety analysis, roadway wear and pricing calculations, etc.
- the current status of exposure estimation including data sources and collection mechanisms
- the future of commercial truck exposure estimation in terms of new or modified data sources, techniques and methodologies (including modeling and simulation) that would provide improved commercial truck exposure data acquisition at the national, state or local levels

The format for the symposium will combine prepared papers and small working group meetings.

Presentation of papers based on abstracts and technical quality will be subject to the approval of the Symposium Technical Committee. Mr. Martin L. Reiss, the Director of Technical Operations of TISA will serve as the project director.

The initial steps of the project will involve:

- contact with potential presenters of technical papers and representatives of select organizations to solicit their cooperation and determine whether the symposium is feasible within the projected time span
- determination of subjects for papers and group discussion

transportation safety – environment protection – occupational & public safety – consumer product safety – energy impacts

TISA

THE INSTITUTE FOR SAFETY ANALYSIS
6400 Goldsboro Road
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(301) 229-8789

CALL FOR COMMERCIAL TRUCK EXPOSURE (MILES OF TRAVEL) ESTIMATION SYMPOSIUM PAPERS

The U.S. Department of Transportation's First National Symposium on Commercial Truck Exposure (Miles of Travel) is tentatively scheduled for April 9-11, 1979 in Washington, D.C. The National Highway Traffic Safety Administration and the Federal Highway Administration are jointly sponsoring the symposium which will be held at the Department of Transportation's Headquarters Building. The Institute for Safety Analysis (TISA) of Washington, D.C. was selected by the Department of Transportation to plan and make arrangements for the conduct of the meeting. Martin L. Reiss, Director of Technical Operations, TISA, is in charge of the Symposium Planning Committee.

Papers describing national, state and local truck exposure gathering are solicited from prospective authors. Authors are expected to provide complete manuscripts for printing in time to permit distribution at the Symposium. Oral presentations will be condensed to cover the paper's highlights in about 30 minutes. Abstracts should be about 200 words in length. The name, address and telephone number of all authors and their affiliations must be provided. Four copies of the abstract should be sent to Martin L. Reiss, TISA, 6400 Goldsboro Road, Washington, D.C. 20034 (301) 229-8789.

TISA

THE INSTITUTE FOR SAFETY ANALYSIS
6400 Goldsboro Road
Washington, D.C. 20034
(301) 229-8789

Because of your interest in this field, we are inviting you to attend a National Symposium on Commercial Truck Exposure, to be held April 9-11, 1979 in Room 2230 of the Nassif Building, U.S. Department of Transportation, 400 7th Street, S.W., Washington, D.C. This Symposium, jointly sponsored by the National Highway Traffic Safety Administration and the Federal Highway Administration, will include discussions of:

- the need for exposure measurement as an element of safety analysis, roadway wear, fuel economy, environmental issues, etc.
- the current status of exposure estimation, including data sources and collection mechanisms.
- the future of commercial truck exposure estimation in terms of new or modified data sources, techniques and methodologies (including modeling and simulation) that would provide improved commercial truck exposure data acquisition at the national, state or local levels.

Many distinguished experts in this area, from both the public and private sectors, will be presenting papers on their own important work on exposure data. A tentative agenda is enclosed for your review.

Because of space limitations, we request that you return the enclosed registration form indicating whether you will or will not be attending. For the convenience of out-of-town guests, the Symposium coordinator has secured a block of rooms at the waterfront Channel Inn Motel, within walking distance of the Nassif Building. If you wish to use these accommodations, please complete the enclosed room reservation form and return it directly to the Channel Inn by March 23, 1979. If the form is not received by this date, the Motel cannot guarantee the special rate quoted on the reservation form. Symposium attendees will be responsible for their own expenses.

The major goal of the Symposium will be to recommend to the Department of Transportation specific actions in the exposure area. We think this has important implications for the trucking industry, environmentalists, highway safety, State and local governments, etc. We hope that you can join us in this effort.

Sincerely,

MR:bjf
enclosures

Martin Reiss
Vice President

occupational & public safety - consumer product safety - energy impacts

REGISTRATION FORM

SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE ESTIMATES

Sponsored by:

Federal Highway Administration
National Highway Traffic Safety Administration

April 9-11, 1979
Department of Transportation Headquarters
Nassif Building, Room 2230
400 7th St., S.W.
Washington, D.C.

NAME ☐ DR ☐ MR ☐ MS ☐ MISS ☐ MRS

INVITEE _____
FIRST MIDDLE LAST

☐ I PLAN TO ATTEND ☐ I DO NOT PLAN TO ATTEND

TITLE _____

ORGANIZATION _____

MAILING ADDRESS _____
No. STREET

_____
CITY STATE ZIP CODE

TELEPHONE ( ) _____

Please complete and return this form as soon as possible to:

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Form 5

TISA

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You previously indicated you were interested in attending the First National Symposium on Commercial Truck Exposure Estimation, to be held April 9-11, 1979 in Room 2230 of the Nassif Building, U.S. Department of Transportation, 400 7th Street, S.W., Washington, D.C.

I am enclosing for your review the Tentative Agenda. A copy of the Final Agenda will be distributed to all participants at the registration table prior to the opening session of the Symposium. Please let us know, either in writing or by phone, of your definite intent to attend.

If you are aware of any other interested parties, please forward their names to Miss Bobbi Fox at the above address, or have them contact her directly either in writing or by phone at (301) 229-3000.

I look forward to meeting you on April 9th.

Very truly yours,

Marty L. Reiss
Vice President

MLR:bjf
enclosure

transportation safety - environment protection - occupational & public safety - consumer product safety - energy impacts

February 2, 1979

Dear Symposium Participant:

We are delighted that you will be attending the Symposium on Commercial Truck Exposure. We have obtained a block of hotel rooms at a special rate at the popular Channel Inn, a waterfront motel within walking distance of the site of the Symposium, Department of Transportation headquarters.

If you wish to use these accommodations, please complete and return the enclosed reservation form to the Channel Inn before March 23, 1979. The Inn cannot guarantee the negotiated rate quoted on the form unless your reservation form is received by this date.

Taxicab fare from Washington National Airport to the Channel Inn will be approximately $5.00.

We look forward to seeing you on April 9th. You will receive a tentative agenda for the Symposium shortly.

Thank you.

Sincerely,

Marty

Marty Reiss
Director of Technical Operations

MR:bjf
encl.

P.S. Please advise Mr. Reiss at The Institute for Safety Analysis of any requirements that you have for audio-visual equipment such as slide projector, video-tape equipment, etc.

AUDIO-VISUAL EQUIPMENT REQUEST FORM

In order to expedite your audio-visual requirements for your presentation at the National Symposium on Commercial Truck Exposure, it is necessary for you to complete the following form and return it to Mr. Martin Reiss by Friday, February 23, 1979. If you have no audio-visual requirements, please so indicate and return this form to the address below.

_____ I will require no audio-visual equipment

I will require the following audio-visual equipment item(s) for my presentation:

_____ 35 mm slide projector

_____ overhead projector

_____ 16 mm movie projector

_____ flip chart

_____ blackboard

_____ Other (specify):_____

_____

Please return this form to:

Martin Reiss
The Institute for Safety Analysis
6400 Goldsboro Road
Bethesda, Maryland 20034

(301) 229-8789

_____
(Name - please print)

TISA

NATIONAL SYMPOSIUM FOR COMMERCIAL TRUCK EXPOSURE

Eligibility for Participants' Reimbursement,
Travel and Subsistence Expenses

The reimbursement of expenses incurred by reimburseable participants is governed by Federal regulations which provide for the following:

(1) Intercity Travel

The cost of first class rail or economy class air travel via the most direct route between traveler's domicile (or permanent duty station) and the conference site, and return. Private automobiles may be used in lieu of public transportation; reimbursement for private car use will be made at the rate of 17¢ per mile for shortest available route and limited to the lesser of the mileage multiplied by that rate or the least cost of the two public transport modes noted above.

(2) Travel between domicile (or permanent duty station) and railroad station or airport, and between railroad station or airport and conference site

Where available, cost of mass-transit shall be reimbursed. If such public transport mode is not available, taxi fare or use of private car, the latter at above described terms, shall be paid for.

(3) Lodging and Subsistence

Actual expenses incurred for hotel accommodations and subsistence shall be reimbursed, but in no event in excess of $50.00 per 24-hour day or prorata. The period for which actual expenses or per diem shall be paid commences with the time of departure from domicile or permanent duty station, provided it is not earlier than necessary for timely arrival at the conference site and terminates with return to departure point, provided it is not later than the earliest at which the departure point can be reached upon conclusion of the conference by use of the selected travel mode.

Each participant who is eligible for reimbursement is provided a Request for Travel and Subsistence Expense Reimbursement form; it must be completed in all applicable categories, proof of incurred expenses (airline ticket stub, hotel invoice, parking

receipt, etc.) stapled to the form, and mailed to the address shown thereon. Forms must be mailed not later than five days after conclusion of the conference to which the reimbursement request pertains. A check payable to the order to the participant or the payee designated by him/her for the approved amount will be mailed promptly to the address appearing on the request form.

eturn To: TISA
6400 Goldsboro Road
Washington, D.C. 20034

Name of Participant _____ Form 9

Workshop No. 9968

PARTICIPANT'S REQUEST FOR REIMBURSEMENT

NATIONAL SYMPOSIUM ON COMMERCIAL TRUCK EXPOSURE

April 9-11, 1979

A. INTERCITY TRAVEL: Roundtrip from _____ to _____ by: air, rail, private car*

(Auditor's Col., $)

i. Railfare/airfare, class of service _____, amount $_____

ii. Private car, odometer reading, end _____
start _____
miles _____ @ 17¢ amount $_____

Parking fees $_____

B. LOCAL TRAVEL:

i. from _____ to _____ mode _____ cost, $_____
ii. from _____ to _____ mode _____ cost, $_____
iii. from _____ to _____ mode _____ cost, $_____
iv. from _____ to _____ priv. car miles ____,
@ 17¢ cost, $_____
Parking fees $_____

Total local travel $_____

C. SUBSISTANCE OR PER DIEM:

Date, time trip started __/__/7__, ____am/pm; Date, time trip completed __/__/7__, ____am/pm

Total trip duration, days and fractions _____ Maximum permissable per diem (days x 50.00)

i.■ Itemized expenses (list by type, vis. lodging, food, incidentals) Amount $_____

type _____ amount $_____
type _____ amount $_____
type _____ amount $_____
type _____ amount $_____

Total itemized expenses $_____

ii.■ Per diem in lieu of itemized expenses

_____ days @ 50.00, per diem amount $_____

D. TOTAL EXPENSES CLAIMED (A+B+C) $_____

I herewith request reimbursement of the amount shown in line D. and certify that the expenses were incurred by me, that neither myself nor my sponsoring organization has or shall claim reimbursement from any other payor.

i. Signature of Participant _____ Date: _____

ii. Issue check to order of (if other than E.I.) _____

iii. Address to which check is to be sent: _____

_____

Enclosures (no.) _____

* Circle applicable mode.
■ Complete item i. or ii.

(Check No. _____ Date: _____)

The all-new Channel Inn is your port of call in Washington.

It's Washington's WATERFRONT Motel, in an exciting section of town just minutes away from National Airport, Capitol Hill, Union Station and downtown Government, Business and Cultural Centers.

The all new CHANNEL INN offers beautiful decor, color TV, free parking and patioed bedrooms overlooking the Channel. Dinner, pleasing to an Admiral's palate, is to be enjoyed in the popular PIER 7 Restaurant. Sip Cocktails and dance or listen to live music in the Engine Room Lounge. Snack in the DRY DOCK.

SO . . . steer a straight course to a beautiful WATERSIDE spot, the CHANNEL INN. Just fill in the attached reservation card and mail it to us and your Stateroom will be waiting for you

For Additional Information, call 202 / 554-2400.

PLEASE RESERVE

Truck Exposure Symposium
April 9-11, 1980

____ *Single Room(s) 1 Bed*
____ *Double Room(s) 1 Bed*
____ *Double Room(s) 2 Beds*

FOR ARRIVAL _____ FOR DEPARTURE _____
date

NAME _____

COMPANY OR GROUP _____

ADDRESS _____

CITY STATE ZIP _____

CONFIRMING TELEPHONE NUMBER _____

RATES

1 person 1 bed	$[illegible]4.00
2 persons 1 bed	$[illegible]2.00
2 persons 2 beds	
Each additional person over 12 years of age	$4.00

SUITES AVAILABLE ON REQUEST

I UNDERSTAND THAT RESERVATIONS ARE HELD UNTIL 6 PM ONLY, *UNLESS PREPAID*

PLEASE CONFIRM _____
all dates

INSTRUCTIONS FOR PREPARING TECHNICAL PAPERS

The following set of instructions is provided for your use in preparing your technical paper for the Symposium on Commercial Truck Exposure Estimates, April 9-11, 1979, Washington, D.C. Adherence to these guidelines will insure uniformity of all papers and expedite reproduction for distribution prior to the Symposium.

Title Page

The title page should include the title of the paper, the author's name, affiliation, city, state, plus any co-authors. These items should be centered on the page and spaced so that they are easily read.

Text

1) spacing - all pages should be single spaced; double spaced between paragraphs.

2) margins - standard margins of one inch top, bottom, and right; one and one half inches on left to accommodate binding.

3) exhibits - should be kept to a minimum and be easily Xeroxed. No photographs may be used as they cannot be reproduced.

4) paper - 8½" x 11" please. It is preferred that no colored paper be used as it will make a less than adequate Xerox copy.

If you have any questions, or cannot adhere to these guidelines for any reason, please contact Bobbi Fox at (301) 229-3000 to discuss alternatives.

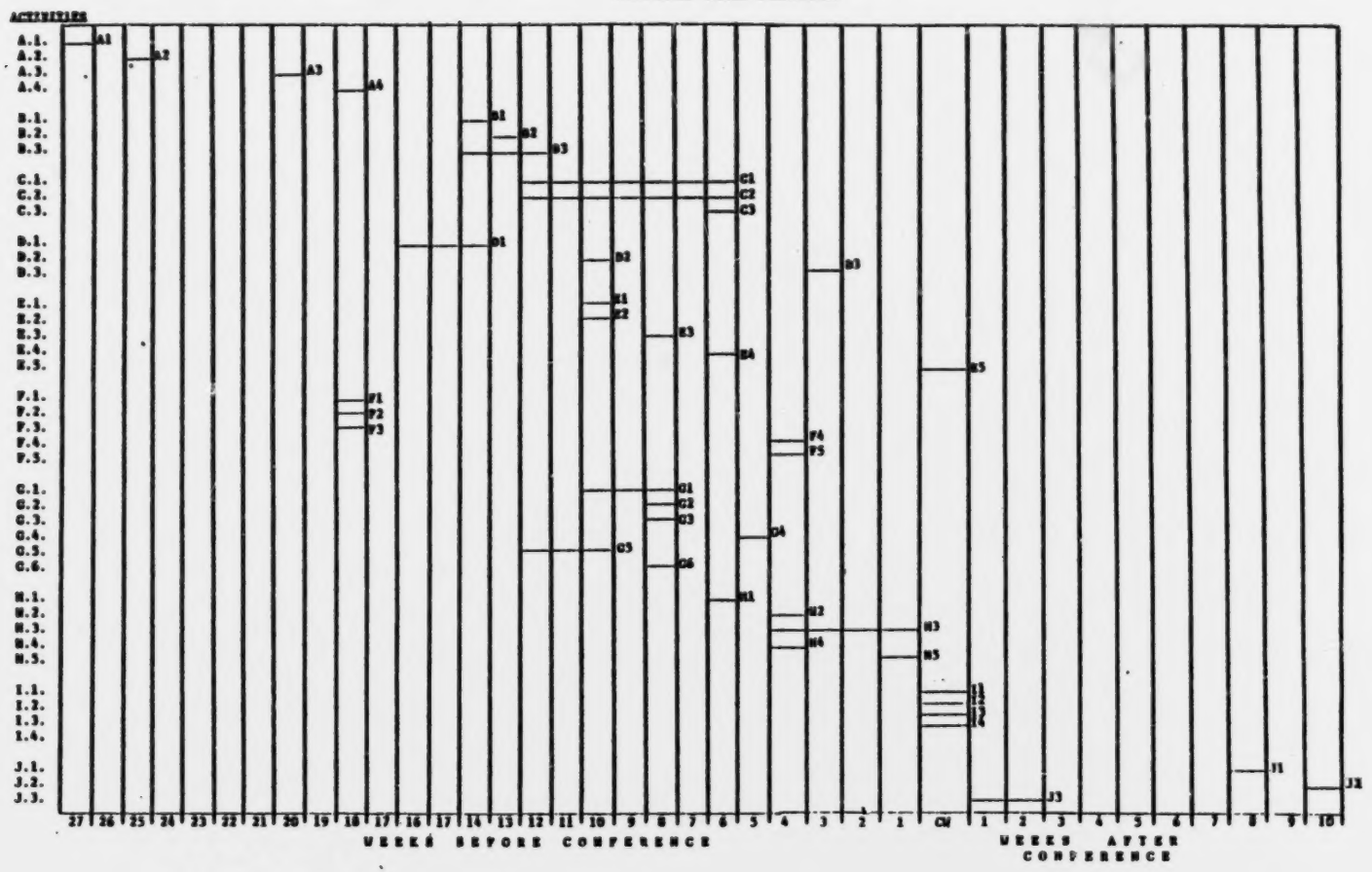
Thank you.

PROPOSED WORK PLAN AND TIME SCHEDULE FOR THE CONFERENCE

ACTIVITIES	CONFERENCE TIME PERIOD (weeks)
A. Preliminary Planning	
*1. Prepare Work Plan	27 BC
*2. Review State of the Art	25 BC
*3. Contact Potential Contributors	20 BC
*4. Solicit Formal Papers	18 BC
B. Evaluation of Responses	
*1. Evaluate the Response	14 BC
*2. Recommend Next Course of Action	13 BC
*3. Review Abstracts, Contact Speakers Again if Necessary	14-12 BC
C. Preparation of Papers	
1. Oversee Progress in Preparation of Papers	12-6 BC
2. Provide Other Assistance	12-6 BC
3. Completed Papers Due	6 BC
D. Hotel and Vendors	
*1. Hotel Search and Tentative Holds	16-14 BC
*2. Mail Hotel Information to Out-of-Town Participants	10 BC
3. Hotel Reservations Due	2 BC
E. Development of Agenda	
*1. Meet with P.O. to Develop Meeting Format	10 BC
*2. Draft Tentative Agenda Using Completed Papers	10 BC
3. Mail Tentative Agenda to Participants	8 BC
4. Draft Final Agenda	6 BC
5. Distribute Final Agenda	CW
F. Mailings and Forms	
*1. Develop Letter of Invitation and Review with P.O.	18 BC
*2. Develop Invitee Status Log	18 BC
*3. Mail Invitations, Enclosures	18 BC
*4. Follow-up Non-Response to Invitations if Response is Low	4 BC
5. Conference Note Printed in Federal Register	4 BC

*These activities were substantially completed as of 2/12/79.

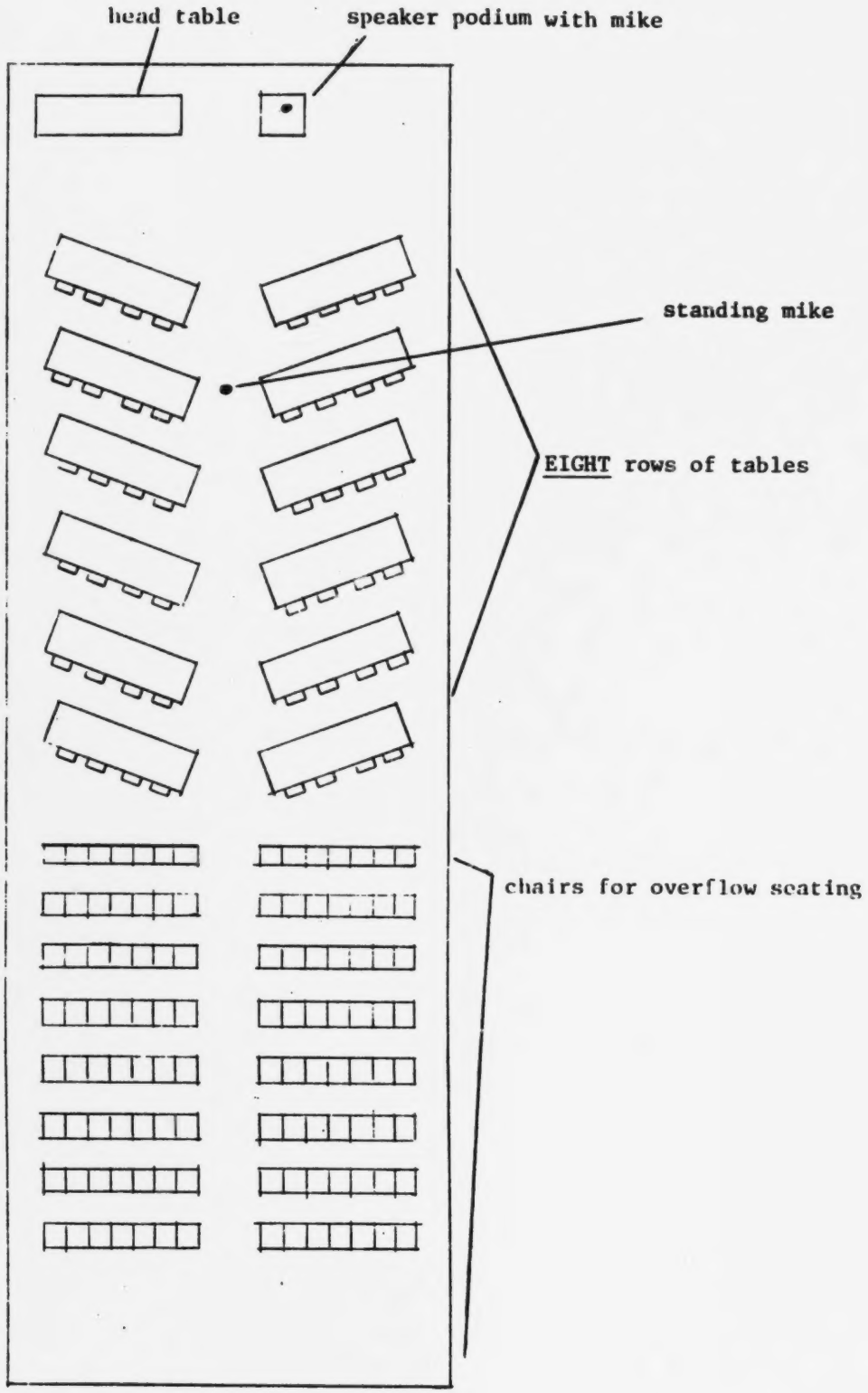
ACTIVITIES	CONFERENCE TIME PERIOD (weeks)
G. Speakers	
1. Prepare and Send Speaker Information About Logistics, Papers, Request for Biography, and Audio-Visual Needs	10-8 BC
2. Invite Keynote Speaker	8 BC
3. Review Papers and Secure Approval of Technical Committee	8 BC
4. Prepare Papers for Publication	5 BC
5. Assess Need for Audio-Visual Equipment	12-10 BC
6. Select Audio-Visual Vendor and Order Equipment	8 BC
H. Conference Preparations	
1. Design Program and Submit to P.O. for Approval	6 BC
2. Print Program and Deliver 120 Copies to P.O.	4 BC
3. Monitor Copies of Reservation Confirmations Sent by Hotel to TISA	4-1 BC
4. Prepare Badges and Place Cards	4 BC
5. Pack Materials and Supplies	1 BC
I. Conference	
1. Arrive at Conference Site; Set Up Materials and Supplies	CW
2. Supervise all Conference Functions; Provide Support Services as Needed	CW
3. TISA Staff Take Notes of All Sessions	CW
4. Pack Supplies, Return to Office	CW
J. Post-Conference	
1. Prepare Advance Copy of Final Report	8 AC
2. Deliver Final Report	10 AC
3. Receive and audit reimbursement forms; send checks	1-2 AC


PROPOSED WORK SCHEDULE
ACTIVITIES
A.1.
A.2.
A.3.
A.4.
B.1.
B.2.
B.3.
C.1.
C.2.
C.3.
D.1.
D.2.
D.3.
E.1.
E.2.
E.3.
E.4.
E.5.
F.1.
F.2.
F.3.
F.4.
F.5.
G.1.
G.2.
G.3.
G.4.
G.5.
G.6.
H.1.
H.2.
H.3.
H.4.
H.5.
I.1.
I.2.
I.3.
I.4.
J.1.
J.2.
J.3.
27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 CW 1 2 3 4 5 6 7 8 9 10
WEEKS BEFORE CONFERENCE
WEEKS AFTER CONFERENCE

271

Form 12-2

PROPOSED FACILITY ARRANGEMENT



TISA

THE INSTITUTE FOR SAFETY ANALYSIS
6400 Goldsboro Road
Washington, D.C. 20034
(301) 229-8789

April 16, 1979

Your participation in the National Symposium on Commercial Truck Exposure Estimation, held April 9-11, 1979, was greatly appreciated.

Please find enclosed a list of Participants and Speakers for your use.

Very truly yours,

Marty

Martin L. Reiss
Vice President

MLR/tmk

Enclosure

If you are interested in serving on an informal committee recommending truck exposure descriptors & methods of obtaining them drop me a line. Thanks again

Marty